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INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.

28660/36 ; 28661/36.

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THE

WELSH JOURNAL
OF
AGRICULTURE.

THE JOURNAL OF THE WELSH
AGRICULTURAL EDUCATION CONFERENCE.

Vol. V.-

28660/36.

JANUARY, 1929,-30

*Published for the Welsh Agricultural Education
Conference by the University of Wales Press
Board (Cardiff), and sold by all Booksellers.*

MADE AND PRINTED IN GREAT BRITAIN BY
WOODALL, MINSHALL, THOMAS AND CO., LTD.,
PRINCIPALITY PRESS, WREXHAM.

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THE CATTLE POPULATION OF WALES AND THE CATTLE SUPPLY.[1]

By A. W. ASHBY, M.A., and THOMAS LEWIS, B.Sc., M.S.,
University College, Aberystwyth.

[Special attention to the cattle industry of Wales is given in this issue of the *Journal* because of the importance of this question at the present time and because of the general interest shown in the subject at the National Conference on the Breeding and Marketing of Cattle which was organised by the Welsh Department of the Ministry of Agriculture at Aberystwyth in November, 1928.—GEN. ED.]

The land at the disposal of farmers in Wales is essentially suitable for pastoral use. Hence the characteristic features of agricultural production are the products of the flocks and herds. Wales has more cattle per 100 acres of cultivated area than any other part of Great Britain. In 1927 the numbers of cattle per 1,000 acres were as follows :—

TABLE I.

	Total cultivated area.	*Total Cattle.**	*Per 1,000 acres.*
Great Britain and Ireland (1922)	45,458	12,231	269
Great Britain	30,272	7,485	247
England and Wales	25,590	6,275	245
England	22,812	5,446	239
Wales	2,778	829	297
Scotland	4,682	1,210	258

* Agricultural Statistics, Part I, 1927.

If the herds are divided into dairy and other cattle the figures show that Wales is predominantly a cattle raising country.

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[1] Many of the figures given in this study are necessarily of the character of estimates. The figures as recorded each year in the *Agricultural Statistics* are given in Appendix A. The figures for individual years on which those of the Summary Tables included in this study are based are given in Appendix B. It will be seen that " Cows and Heifers in Milk and in Calf " were recorded together for the years 1867 to 1913 inclusive. " Cows in Milk and in Calf " were recorded from 1914 to 1927. " Heifers in Calf " were

(*Continued at foot of next page*).

TABLE II.

	Total cultivated area. (000)	*Total cows and heifers.*† (000)	*Per* 1,000 *acres.*	*Total other cattle.*† (000)	*Per* 1,000 *acres.*
Great Britain and Ireland	45,458	4,854	107	7,377	162
Great Britain	30,272	3,251	107	4,234	140
England and Wales	25,590	2,790	109	3,484	136
England	22,872	2,447	107	2,999	131
Wales	2,778	344	124	485	175
Scotland	4,682	460	98	750	160

† As recorded in the *Agricultural Statistics.*

Over great parts of Wales the typical cattle industry is that of butter-making, with stock-raising, and the two divisions of North and South Wales still use a greater proportion of their supply of milk for making butter and cheese on the farms than any of the other divisions of England and Wales.[2]

The cattle population increased fairly steadily for many years until it reached its highest point at 868,648 in 1916. Since then it has shown some decline, to 770,000 in 1921, and a subsequent rise to 829,000 in 1927. The total numbers in 1927 were higher than at any period previous to 1914.

The supply of cattle of various types, however, is more closely related to the uses made of cattle on farms than to the total population, and in Wales, as elsewhere, the tendency towards a larger number of cattle for dairy purposes is to be seen. Other changes also occur. At the end of last century and the beginning of this century there was a marked tendency to reduce the age at which store cattle were sold. During the eighteen-seventies and in some parts of the next decade fairly large numbers of cattle three years old and upwards were included in the cattle population. These have steadily been reduced until in recent years only very small numbers of store cattle have been kept until they reach the age of three years.

(*Continued from foot of previous page*).

recorded separately from 1914 to the present time. " Bulls " were recorded from 1919 to the present. " Cattle under two years " were recorded from 1867 to 1892; and separated as " Under one year " and " One year and under two " in 1893, and so continued. " Cattle over two years " have been recorded throughout the period. The yearly totals of cattle of all kinds as given in the estimates correspond with the recorded totals. The number of " heifers in calf " given for the years for which this class has been recorded are not sufficient to maintain the dairy herd, and consequently it is necessary to add a number of heifers to those recorded, and consequently to reduce the numbers of other " cattle over two years ". Death rates have been allowed for in all estimates of sales.

[2] *The Agricultural Output of England and Wales.* Cmd. 2815, 1927, p. 66.

Although a very large part of the herds of cows in Wales are to be regarded more as "breeding herds" than as "dairy herds" in the specialised sense, they must still have some of the characteristics of the dairy herd. An increase even of breeding herds means an increase in the number of draft cows which go to market. Making an increase in the breeding herd temporarily reduces the supply of stores offered for sale by taking from the available supply the heifers necessary to make the increase. And in recent years there appears to have been some tendency towards increasing the slaughter of calves for veal in Wales as in the rest of the country.

The approximate constitution of the dairy herd since 1867 has been that shown by the following figures.

TABLE III.

Estimate of the Breeding and Dairy Herd of Wales.

(Yearly average for each five year period).

Five year periods.	*Cows in Milk and in Calf.*	*Heifers in Calf.**	*Maintenance Heifers not in Calf.†*	*Total Heifers.*	*Bulls.*	*Total Breeding and Dairy Herd.*
1867-71	242,316	25,673	27,801	53,514	10,719	306,549
1872-76	248,245	26,302	28,608	54,910	10,982	314.137
1877-81	247,412	26,217	28,507	54,724	10,945	313,081
1882-86	260,115	27,559	29,976	57.535	11.467	329,117
1887-91	271,145	28,728	31,185	59,913	11.995	343,053
1892-96	268,866	28,486	30,985	59,471	11,894	310,231
1897-02	269,438	28,547	30,991	59.538	11.919	340.895
1902-06	268,390	28,436	30,931	59.367	11,873	339.630
1907-11	274,763	29,111	31,664	60,775	12,157	317.695
1912-16	281,400	29,441	32.369	61.810	12.434	355.644
1917-21	288,295	30,667	33,236	63,903	13,102	365.300
1922-26	299,341	32,119	34,539	66,658	12,138	378,137
1927	308,288	35,585	35,823	71,417	11,891	391.596

* As at June 4th.

† Heifers required for herd maintenance, not in calf on June 4th.

From this basic herd there are sales of draft cows and draft bulls. These will not quite equal the numbers required for the

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maintenance and increase of the herd because of deaths and casualties. The following represents the approximate sales of this class of stock for the above periods.

The farmers of Wales do not use all the cattle bred in their herds for dairying and fattening, and they sell their surplus outside the country. If these sales may be described as " local exports ", these exports consist of small numbers of yearling cattle, some draft cows, some in-calf heifers, a small number of milking cows, and fairly large numbers of stores of two years of age and over. A few rearing calves are sold from South Wales, but also calves are bought from some English districts, especially for the farms of North Wales.

TABLE IV.

Estimated Sales of Draft Cows and Draft Bulls in Wales.
(Yearly average for each five year period).

Periods.	*Cows.*	*Bulls.*	*Total.*
1867-71	40,386	3,573	43,959
72-76	41,376	3,661	45,037
77-81	41,235	3,648	44,883
82-86	43,852	3,822	47,174
87-91	45,191	3,998	49,189
92-96	44,811	3,965	48,776
97-01	44,906	3,973	48,879
1901-06	44,732	3,958	48,690
07-11	45,794	4,052	49,846
12-16	46,900	4,145	51,045
17-21	48,049	4,367	52,416
22-26	49,890	4,046	53,936
1927	51,381	3,964	55,345

With an increasing breeding and dairy herd the numbers of draft stock are bound to increase, except possibly in the case of bulls which do not necessarily increase in numbers with the cows. There has been a recent tendency to decrease the number of bulls kept, and this is reflected in the estimate of numbers of draft bulls for sale and disposal. In the six counties of North Wales most of the draft cows are sold in store condition, mainly to go to pastures in the English Midlands. In South Wales the fattening of draft cows is more frequent.

The breeding and dairy herd, as shown in Table III, is the foundation on which rests the raising of store stock for sale, or for fattening purposes within the Welsh counties.

As previously stated, some calves are sold as veal, and the number of these is believed to be increasing, but no estimate of the exact numbers sold is now possible. A few calves may also be sold for stock purposes, but probably the number bought from England is greater than the number sold.

Transactions in all classes of bovine stock occur every day of the week throughout Wales, and the industry is so organised as to allow a certain amount of specialisation in stock-breeding, rearing, raising and fattening on different farms within the counties. This study is not concerned with these transactions, but only with those of final sale for consumption or of a local export character.

Apart from the transactions between farm and farm and district and district within the Principality, the sales of yearling cattle have shown a good deal of variation from 1867 to the present. Many factors affect the sales of yearlings. During the latter part of last century, when a poorer type of animal was commonly found on Welsh farms, the effective fertility of cows was lower than at present, and probably showed more variations. The death rate among young stock would vary greatly from year to year. Farmers had to depend almost entirely on home grown foodstuffs for rearing their young stock. Little was known in farm practice about the principles of feeding, and indeed little could be done to improve matters in this respect when it was not possible to resort to purchased foods to augment the food stuffs grown on the farm as, at this period, the quantity of animal foodstuffs imported into the country was very low, and the variety was undoubtedly very limited. Consequently, in bad harvest years farmers would be faced with a high death rate amongst young cattle, and in a large number of cases may have had to sell out yearlings owing to lack of keep, whereas in good harvest years the death rate would tend to be lower and more cattle could be carried on to maturity. Increases or decreases in the total breeding herd would also cause corresponding changes in the number of yearlings on farms, and would affect sales in particular years. In addition to some bad years for diseases amongst animals, which are still remembered by many, the last two decades of the century witnessed an intense and prolonged agricultural depression, and this again is a potent factor affecting the position of young cattle, when farmers were forced to sell cattle of all ages in order to maintain their cash incomes at certain periods.

Yet another factor which would affect the supplies of yearlings would be excessive sales of these cattle in certain years necessitating the purchase of stock in the years immediately following in order to make up the deficiency. Again, heavy sales of cattle over two years old in particular years would result in the buying of yearling cattle to make up the loss.

In the case of yearling cattle the latter part of last century was characterised by heavy sales in certain years, and heavy purchases in others. It was a period of wide fluctuations caused in varying degrees by the factors already mentioned. On the whole, it is estimated that the sale of yearlings off Welsh farms was nearly twice as heavy during the last twenty-five years of nineteenth century as it has been during the first twenty-five years of the twentieth century. During the latter period it will be seen that on the whole the sale of yearlings tends to diminish. This is partly due to an increase in the slaughter of veal calves and to improvements in the breeding, feeding, and management of livestock, as farmers have no longer to rely on homegrown foods in order to maintain their herds. There have been even in recent years, excessive sales of yearlings or of two year old cattle in certain years, necessitating the buying in of yearlings in other years, but the trade in yearlings has gained largely in stability during the last two decades. When Welsh farmers have to resort to buying-in yearlings the supply is obtained partly from Ireland and partly from over the English borders. There was a heavy purchase of yearlings in 1921-22 following relatively heavy sales of yearlings in 1920, and very heavy sales of cattle over two years old during the war, and especially immediately after the war.

Sales have recently been undoubtedly lower than usual as a result of the war-time depletion of the herds.

The average sales of yearling cattle in each year of the five-year periods from 1868 to 1927 is shown below.

External or "Export" Sales of Yearlings.

Five years ending	June 4th,	1872	1,993
Do.	Do.	1877	9,491
Do.	Do.	1882	7,395
Do.	Do.	1887	8,987
Do.	Do.	1892	11,259
Do.	Do.	1897	2,094
Do.	Do.	1902	5,417
Do.	Do.	1907	5,648
Do.	Do.	1912	8,522
Do.	Do.	1917	5,153
Do.	Do.	1922	2,599
Do.	Do.	1927	1,525

The trade in the older store cattle is one of the oldest trades of Wales, and one for which it has long been famous. But it is probable that this trade never reached greater proportions than during the war years and the years immediately following. During the period 1918-22 a yearly average of about 157,000 became available for fattening or for sale each year.

The numbers of store cattle recorded by the *Agricultural Statistics* to be on farms on June 4th each year for the last ten years have been as follows :—

I. *Under one year.*		II. *One to two years.*	
1917	224,000	1918	212,351
1918	217,860	1919	211,997
1919	205,721	1920	184,975
1920	163,460	1921	157,299
1921	188,665	1922	190,102
1922	183,578	1923	180,788
1923	186,245	1924	180,654
1924	192,899	1925	186,666
1925	199,848	1926	189,600
1926	196,212	1927	186,683
1927	204,376		

N.B.—Column II represents the same group of cattle in the following year.

With the recent increase in this class of cattle a resumption of normal selling may be expected. But the great majority of the yearling cattle remain on the Welsh farms to meet the requirements of maintaining the dairy herd and to make the supply of two year old cattle for fattening within the country, or for sale outside its borders.

Of the two year old cattle produced in the country, and available for final disposal each year, a fairly large proportion are fattened within the Welsh counties and a smaller proportion are sold to English farmers. Of the latter, some are sold as heifers either in-calf or ready for service for the dairy herds of the North Western Counties of England, but more are sold to fattening farms. Of those kept and fattened on Welsh farms a large number eventually are sold in English markets. The store cattle of Wales find their way to farms in many parts of the Midland, Eastern, and Northern Counties of England. The estimated supply available for export sale, for local fattening and then for local consumption or for export to England in fat condition, on the average of each year in the five-year periods since 1868 is as follows :—

Five years ending	June 4th,	1872	71,559
Do.	Do.	1877	88,256
Do.	Do.	1882	91,185
Do.	Do.	1887	103,838
Do.	Do.	1892	102,782
Do.	Do.	1897	128,802
Do.	Do.	1902	132,269
Do.	Do.	1907	136,555
Do.	Do.	1912	140,441
Do.	Do.	1917	145,036
Do.	Do.	1922	157,111
Do.	Do.	1927	127,448

It is not known exactly what proportion of these are sold outside Wales. In the cases of the six counties of North Wales and of Cardiganshire by far the larger proportion eventually moves over the border to England. The majority of store cattle are sold in early spring. During the period June to December all fat cattle surplus to local requirements are sold outside the country. From January to May there is an opposite movement of fat cattle from the English markets into Wales. During this period there are not enough cattle fattened within the Principality to meet local requirements, and the shortage is greatest as a rule during February and March.

In the six counties of South Wales the conditions are different. There is a movement of store cattle out of the country in the spring and autumn and a reverse movement of fat cattle from English markets almost throughout the year, but here again the inward movement of fat cattle is heaviest from January to May.

Of the cattle two years old and over sold outside the Principality it is estimated that about 60-65% have been sold for immediate slaughter during the last three years. About 35-40% were sold outside the country as feeding or breeding stock.

During the period under review there has been a great change in this respect in most parts of Wales. The change in demand on the consumers' markets from heavy prime fat beasts to a smaller and leaner animal has enabled Welsh farmers to finish an increasing proportion of their cattle for the butcher. This tendency has been made stronger with the rapid increase of grassland which has been proceeding since the war.

The total " herd " of Wales since 1867 has been constituted as shown below. The total of the breeding herd is given, but the analysis of the breeding herd has been shown above (Table III).

TABLE V.
The Cattle Population of Wales.
(Yearly average for five year periods).

Periods.	*Total breeding herd.**	*Cattle under one year old.*	*Cattle one—two years old.†*	*Cattle over two years old.‡*	*Total Cattle.*
1867-71	306,549	119,217	105,200	93,019	623,985
1872-76	314,137	143,662	126,200	98,303	682,302
1877-81	313,081	143,668	125,600	94,717	677,066
1882-86	329,117	163,223	144,000	92,631	728,976
1887-91	343,053	168,266	144,200	90,539	746,058
1892-96	340,231	175,706	160,753	92,079	768,769
1897-01	340,895	195,076	178,970	62,428	777,369
1902-06	339,630	197,146	181,465	60,345	778,586
1907-11	347,695	200,008	183,899	57,338	788,940
1912-16	355,644	214,378	194,540	53,558	818,120
1917-21	365,300	199,941	195,392	57,949	818,582
1922-26	378,187	191,756	185,162	49,562	804,617
1927	391,596	204,376	186,683	46,143	828,798

* As per Table III including bulls. † Excluding bulls throughout.
‡ Excluding bulls and all heifers for the maintenance of the dairy herd.

From 1867 to 1896 there was a steady increase in the breeding herd. From 1897 to 1906 there was a small decrease. From 1907 to 1927 there was again a rapid increase in breeding stock, the increase being most marked in the years after the war.

The estimated changes in the various classes of cattle from 1867 to 1927 and from 1894 to 1927 have been as follows :—

	1867-1927	1894-1927
Breeding herd ...	+ 27.7%	+ 18.0%
Under one year old ...	+ 71.5%	+ 24.9%
One to two year old	+ 77.4%	+ 22.3%
Over two year old ...	— 50.4%	— 50.0%
Total herd ...	+ 32.8%	+ 11.9%

The most notable change in the utilisation of the cattle herd is found to be reduction in numbers of other cattle over two years of age on farms on June 4th during the period. Comparing the five year period 1867-71 with 1927 it is seen that the number of these cattle on farms in the latter year was less than half the number shown in the first period. This indicates the increase in turnover of this class of cattle. Stated in another way it shows that in 1927 these cattle were sold off Welsh farms at an age approximately a year younger than was the case in the period 1867-71.

With the improved methods of grass-land management which are within the reach of Welsh farmers there remains a wide scope for increasing the breeding and feeding cattle population. Grass-land production is essentially seasonal, and the extension of the grass acreage as well as the increased productivity of grass-land will of necessity accentuate the seasonality in the production of milk and meat or meat animals. Welsh farmers would do well to aim at a balance between arable and grass-land that will enable them to equalise their supply of produce as far as possible throughout the year. This is especially important in a country where the production of livestock and their products predominates.

APPENDIX A.

Cattle in Wales and Monmouth.—Actual figures as per Agricultural Statistics.

Year.	*Cows and Heifers in milk and in calf.*	*Heifers in calf.*	*Bulls used for service.*	*Other Cattle.*			*Total.*
				Under 1 year.	*1 to 2 years.*	*2 years and over.*	
1867	259,931	—	—	200,142		119,633	579,706
1868	270,479	—	—	231,535		129,857	631,871
1869	272,436	—	—	225,086		130,528	628,050
1870	271,816	—	—	240,697		132,440	644,953
1871	265,286	—	—	242,492		127,367	635,145
1872	265,602	—	—	258,137		117,918	641,657
1873	275,167	—	—	293,412		116,593	685,172
1874	280,008	—	—	294,482		136,208	710,698
1875	276,949	—	—	264,900		153,266	695,115
1876	275,010	—	—	256,682		147,174	678,866
1877	269,412	—	—	256,612		130,563	656,587
1878	267,582	—	—	259,081		121,126	647,789
1879	277,379	—	—	286,770		121,312	685,461
1880	277,062	—	—	283,484		136,090	696,636
1881	276,697	—	—	278,634		143,525	698,856
1882	276,348	—	—	285,732		126,598	688,678
1883	276,833	—	—	303,333		116,903	697,069
1884	284,049	—	—	321,710		122,544	728,303
1885	298,547	—	—	327,354		133,512	759,413
1886	302,594	—	—	317,099		151,722	771,415
1887	301,571	—	—	301,423		143,245	746,239
1888	293,112	—	—	288,778		129,741	711,631
1889	289,612	—	—	297,076		123,933	710,621
1890	300,768	—	—	336,364		114,876	752,008
1891	314,303	—	—	358,680		136,805	809,788
1892	311,333	—	—	338,671		157,135	807,139

1893		299,827	—	—	165,927	171,485	150,645	787,884
1894		290,064	—	—	163,668	156,494	130,212	740,438
1895		293,246	—	—	183,055	159,366	113,699	749,366
1896		292,291	—	—	188,366	175,096	103,276	759,029
1897		289,943	—	—	180,933	179,612	103,915	754,403
1898		291,726	—	—	186,360	168,928	100,585	747,599
1899		304,311	—	—	206,263	179,458	95,274	785,306
1900		305,022	—	—	203,912	196,444	102,807	808,185
1901		298,925	—	—	197,912	190,272	104,239	791,348
1902		293,442	—	—	188,713	183,932	102,682	768,769
1903		292,288	—	—	196,605	173,723	95,554	758,164
1904		296,327	—	—	201,112	187,455	93,052	777,926
1905		299,316	—	—	200,820	189,486	100,026	789,648
1906		302,761	—	—	198,478	192,520	104,663	798,422
1907		306,985	—	—	191,044	184,731	106,016	788,776
1908		304,163	—	—	199,904	183,387	94,715	782,169
1909		304,646	—	—	206,150	192,377	91,357	794,530
1910		300,690	—	—	200,383	193,977	94,746	789,796
1911		302,889	—	—	202,558	185,287	98,698	789,432
1912		304,249	—	—	197,224	197,396	104,435	803,304
1913		283,040	—	—	199,611	182,055	109,840	774,546
1914	Cows in milk and in calf.	290,314	28,841	—	217,060	190,442	81,246	807,903
1915		292,431	28,858	--	227,379	207,573	80,963	837,204
1916		293,226	33,243	—	231,618	215,960	94,601	868,648
1917		286,922	36,102	—	224,000	218,910	92,767	858,701
1918		288,679	31,339	—	217,860	212,351	80,344	830,573
1919		296,876	29,025	13,655	205,721	211,997	102,065	859,339
1920		280,399	25,095	13,010	163,460	184,975	107,368	774,307
1921		288,597	31,773	13,125	188,665	157,299	90,531	769,990
1922		299,355	30,980	12,696	183,578	190,102	82,929	799,640
1923		298,108	30,189	11,875	186,243	180,788	82,938	790,141
1924		298,547	33,072	11,972	192,898	180,654	81,505	798,648
1925		300,556	32,143	12,136	199,848	184,666	88,716	818,065
1926		300,187	34,212	12,010	196,212	189,600	84,411	816,582
1927		308,288	35,585	11,891	204,376	186,683	81,974	828,797

APPENDIX B.

Reconstitution of the Cattle Population of Wales, 1867-1927.

Year.	Cows in milk and in calf.	Heifers in calf (in June).	Maintenance Heifers not in calf in June (estimated).	Total Heifers (estimated).	Bulls required.	Total Dairy and Breeding Herd (estimated).	Cattle under 1 year old.	Cattle 1-2 year old (excluding part Bulls).	Cattle over 2 years old (excluding Maintenance Heifers and Bulls) (estimated).	Total (equivalent to Recorded total of all) Cattle.
1867	E 235,030	E 24,901	26,762	51,663	E 10,397	297,090	E 104,676	E 92,000	85,940	579,706
1868	244,567	25,912	27,984	54,096	10,819	309,282	120,929	107,000	94,660	631,871
1869	246,337	26,099	28,387	54,486	10,897	311,720	117,454	104,000	94,876	628,050
1870	245,776	26,040	28,323	54,363	10,873	311,012	126,073	111,000	96,868	644,953
1871	239,872	25,414	27,543	52,957	10,611	303,440	126,955	112,000	92,750	635,145
1872	240,157	25,445	27,676	53,121	10,624	303,902	135,596	119,000	83,159	641,657
1873	248,806	26,361	28,672	55,033	11,007	314,846	153,743	136,000	80,582	685,172
1874	253,183	26,825	29,177	56,002	11,200	320,385	154,749	136,000	99,564	710,698
1875	250,417	26,532	28,858	55,390	11,078	316,885	139,207	122,000	117,023	695,115
1876	248,664	26,346	28,656	55,002	11,000	314,666	135,015	118,000	111,185	678,866
1877	243,602	25,810	28,073	53,883	10,776	308,261	134,020	119,000	95,306	656,587
1878	241,948	25,634	27,872	53,506	10,703	306,157	135,513	120,000	86,119	647,789
1879	250,806	26,573	28,903	55,476	11,095	317,377	150,072	133,000	85,012	685,461
1880	250,519	26,543	28,870	55,413	11,082	317,013	148,790	131,000	99,833	696,636
1881	250,189	26,508	28,832	55,340	11,068	316,597	149,945	125,000	107,314	698,856
1882	249,874	26,474	28,796	55,270	11,054	316,198	150,047	132,000	90,433	688,678
1883	250,312	26,521	28,846	55,367	10,973	316,652	159,675	140,000	80,742	697,069
1884	256,837	27,212	29,598	56,810	11,362	325,009	168,923	149,000	85,371	728,303
1885	269,946	28,601	31,109	59,710	11,842	341,498	171,407	152,000	94,508	759,413
1886	273,605	28,989	31,529	60,518	12,104	346,227	166,064	147,000	112,124	771,415
1887	272,680	28,891	31,424	60,315	12,063	345,058	158,402	139,000	103,779	746,239
1888	265,032	28,080	30,542	58,622	11,724	335,378	151,870	133,000	91,383	711,631
1889	261,867	27,745	29,867	57,612	11,584	331,063	156,215	137,000	86,343	710,621
1890	271,954	28,814	31,840	60,154	12,031	344,139	186,354	146,000	75,515	752,008
1891	284,193	30,110	32,750	62,860	12,572	359,625	188,489	166,000	95,674	809,788
1892	281,507	29,826	32.441	62,267	12,453	356,227	177,520	157,000	116,892	807,139

1893	271,104	28,723	31,242	59,965	11,993	343,062	R 165,927	R 167,487	111,408	787,884
1894	262,276	27,788	30,225	58,013	11,603	331,892	163,663	152,626	92,252	740,433
1895	265,153	28,093	30,556	58,649	11,730	335,532	183,055	155,456	75,323	749,366
1896	264,290	28,001	30,457	58,458	11,692	334,440	188,366	171,199	65,024	759,029
1897	262,166	27,777	30,112	57,889	11,598	331,653	180,933	175,746	66,071	754,403
1898	263,779	27,947	30,198	58,145	11,669	333,593	186,360	165,038	62,608	747,599
1899	275,158	29,153	31,709	60,862	12,172	348,192	206,263	175,401	55,450	785,306
1900	275,801	29,221	31,784	61,005	12,201	349,007	203,912	192,377	62,889	808,185
1901	270,288	28,637	31,148	59,785	11,957	342,030	197,912	186,286	65,120	791,348
1902	265,330	28,112	30,577	58,689	11,738	335,757	188,713	180,019	64,280	768,769
1903	264,281	28,001	30,456	58,457	11,691	334,429	196,605	169,826	57,304	758,164
1904	267,939	28,388	30,877	59,265	11,353	339,057	201,112	183,504	54,253	777,928
1905	270,642	28,674	31,189	59,863	11,973	342,478	200,820	185,495	60,835	789,648
1906	273,756	29,005	31,556	60,561	12,110	346,427	198,478	188,483	65,034	798,422
1907	277,576	29,409	31,987	61,396	12,279	351,251	191,044	180,638	65,843	788,776
1908	275,024	29,139	31,694	60,833	12,166	348,023	199,904	179,332	54,910	782,169
1909	275,461	29,185	31,744	60,929	12,186	348,576	206,150	188,315	51,489	794,530
1910	271,884	28,806	31,332	60,138	12,038	344,060	200,383	169,964	55,389	789,796
1911	273,872	29,017	31,561	60,578	12,116	346,566	202,558	181,248	59,060	789,462
1912	275,102	29,147	31,702	60,849	12,170	348,121	197,224	193,339	64,619	803,303
1913	255,925	27,115	29,393	56,508	11,322	323,755	199,611	178,281	72,899	774,546
1914	R 290,314	R 28,841	33,256	62,097	12,766	365,177	217,060	186,187	39,479	807,903
1915	292,431	28,858	33,478	62,336	12,852	367,619	227,379	203,289	38,917	837,204
1916	293,226	33,243	34,018	67,261	13,059	373,516	231,618	211,607	51,877	868,648
1917	286,922	36,102	33,659	69,761	12,921	369,601	224,000	214,603	50,491	858,701
1918	288,679	31,339	33,346	64,685	12,801	366,165	217,860	208,081	38,161	830,573
1919	296,876	29,025	33,959	62,984	R 13,655	373,515	205,721	211,997	68,106	859,339
1920	280,399	25,095	31,832	56,927	13,010	350,336	163,460	184,975	75,536	774,307
1921	288,597	31,773	33,383	65,156	13,125	366,878	188,665	157,299	57,148	769,990
1922	299,355	30,980	34,421	65,401	12,696	377,452	183,578	190,102	48,508	799,640
1923	298,108	30,189	34,208	64,397	11,875	374,380	186,213	180,788	48,730	790,141
1924	298,547	33,072	34,555	67,627	11,972	378,146	192,898	180,654	54,049	798,648
1925	300,556	32,143	34,670	66,810	12,136	379,502	199,848	184,666	46,950	818,065
1926	300,137	34,212	34,840	69,051	12,010	381,198	196,212	189,600	49,571	816,581
1927	308,288	35,585	35,832	71,417	11,891	391,596	204,376	186,683	46,143	828,798

E—Estimated. R—Recorded in *Agricultural Statistics* each following year.

BEEF PRODUCTION:

SEASONAL VARIATIONS IN THE SUPPLIES AND PRICES OF FAT CATTLE.

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AND

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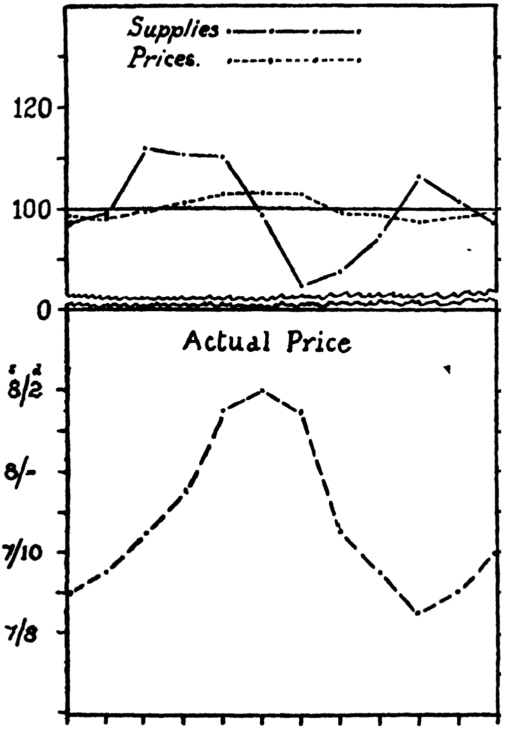
I. General conditions.

During recent years considerable changes in the monthly or seasonable supplies and prices of fat cattle have occurred, and graziers and sellers of grass-fed cattle generally have experienced heavy falls in prices during the autumn months. The causes of these changes are complex, but they appear to have arisen chiefly on the side of production and supplies. On the farming side, the change began to occur about 1911-13. On the average of the

DIAGRAM 1.

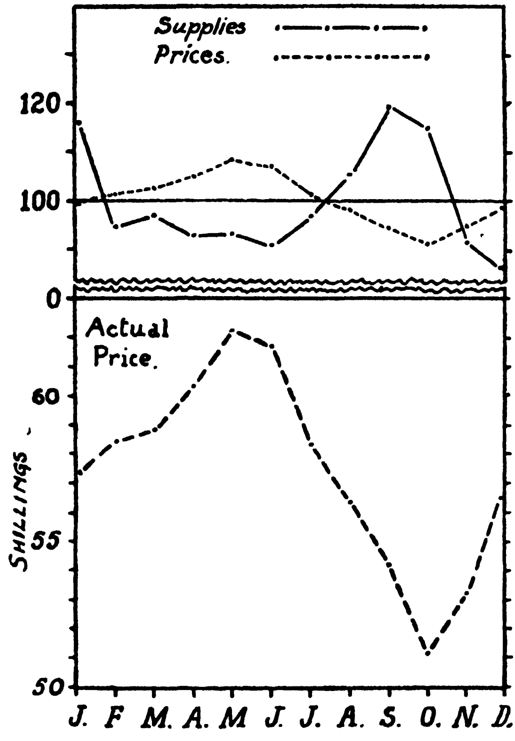
Monthly supplies and prices of fat cattle, 1906-1913. (Deviations from mean). With monthly price per stone d.w. (8 lbs.).



eight years 1906-18 the proportion of the total supply of fat cattle sold in the first half of the year (January—June) was 58 per cent. and that sold in the second half (July—December) was 47 per cent. A proportion of the 47 per cent., mainly those marketed at Christmas, were stall-fed, and it appears that approximately 60 per cent. of the total yearly supply was yard or stall fattened (Diagram 1). But there were indications before 1914 that the systems of beef production were changing. The higher spring

DIAGRAM 2.

Monthly supplies and prices of fat cattle, 1920-25. (Deviations from mean). With monthly price per l.w. cwt. 1922-25.

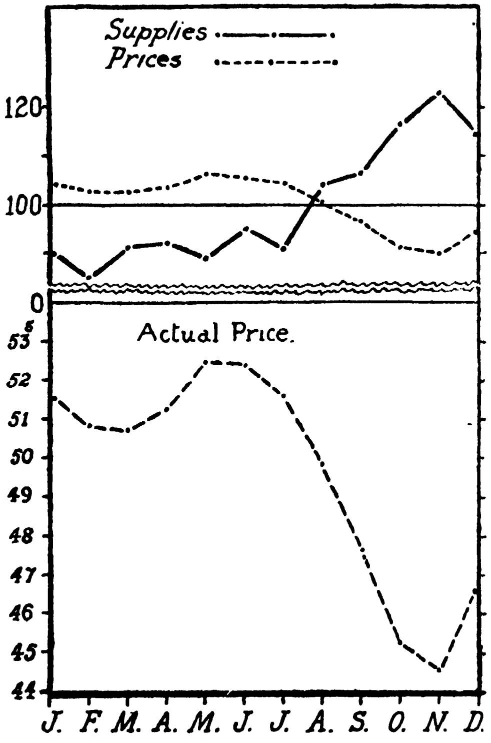


supply gradually declined from 1911, and by 1914 the incidence of the supply had actually changed so that the peak supply month fell in the autumn instead of in the spring months of March to May. In 1914, comparing the supply for the six months, January to June, with that of July to December, the total spring supply was still higher than the autumn supply, but the peak month came in October.

The period 1914 to 1920, owing to exceptional conditions brought about by the war, cannot be used alone to determine trends of supply. It must be pointed out, however, that these years brought about economic conditions which converted pre-war tendencies into actual facts in the ensuing years. There are many disturbing factors in the period 1920 to 1927 which make it difficult to determine general trends. The years 1921 to 1923 were characterised by a violent fall in prices resulting in a severe depression. Coincident with these the rapid laying down of arable land to grass was proceeding, and one year was so unlike another in relation to the incidence of the seasonal supply of cattle that the movements during a single year do not lend themselves to statistical analysis which give any definite results. Again, in 1924 and 1925 there were serious outbreaks of foot and mouth disease which disturbed the seasonality of supply to a large extent. When, however, monthly averages are calculated for the five years 1920-23 and 1925, omitting 1924, seasonal variations in supply for the whole period are clearly shown. The movements in 1926 and 1927 show a remarkable similarity and

DIAGRAM 3.

Monthly supplies and prices of fat cattle, 1926-27. (Deviation from mean). With monthly price per l.w. cwt.



furnish further confirmation of the changes in the seasonality of supply (Diagrams 2 and 3).[1]

It will be seen that the seasonal nature of supply has changed considerably. The proportions of supplies marketed in the first and the second halves of the year for 1926 and 1927 were 45 per cent. and 55 per cent. In 1920-25 supply falls rapidly during January and gradually from February to June. The spring peak supply of winter fed beasts has entirely disappeared and an abnormally high autumn supply has taken its place. A separate diagram (3) is given for 1926 to 1927 showing the supply and price movements during these two years. It shows that the disappearance of winter-fed beasts from the market has proceeded still further, and instead of the peak supply in March the lowest supply for any month of the year occurs in February; there is then a gradual rise in supplies until July, followed by a rapid increase until November and a fall in December.[2]

With a fair balance between winter fattening and grass fattening, the pre-war price curve approximates the average: gradually rising price from January to June, when the peak price is obtained, with a gradual fall to October, and a rise in December. The range of variation between highest and lowest monthly average was 5 per cent. as compared with 15.8 per cent for 1926-27. In the latter years, with a lower supply during the early months of the year, prices were relatively higher during the same months, the highest being reached in May. With a rapidly increasing rate of supply, prices fell from May to November and improved again in December (Diagram 3).

The notable feature of the 1926-27 supply curve is the complete disappearance of the pre-war peak of winter fed beasts, whereas the preceding post-war period still showed a fairly high spring supply.

During the years 1920 to 1927 conditions have arisen in the fat cattle trade which have seriously affected the producer in this country, particularly the producers of grass fed beef.

Briefly, the result of these conditions is that the seasonal movements of prices have undergone an important change. The average yearly price of cattle has shown a severe decline since 1920, but this is partly the result of the rise in the value of money following war time inflation and partly of special causes affecting the trade in beef. This, in itself, is of considerable importance to this branch of farming,[3] but the seasonal fluctuations of prices are also of direct importance.

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[1] The supply curve shown on Chart 2 is based on the average monthly supply for the years 1920, 1921, 1922, 1923, and 1925. The year 1924 has been omitted as supplies were seriously affected by an outbreak of foot and mouth disease.

[2] The figures used for the diagrams relate only to numbers. If average weights per head were added, the effect would be that of raising the quantity of autumn supply, for the heaviest cattle go to market at that period.

From July to November prices for the last few years have fallen abnormally low. This was especially true for the years 1926 and 1927. In the former year the average price per cwt. live-weight for England and Wales fell from 55s. 10d. in May to 46s. 9d. in November, a slump of 9s. 1d. per cwt. live-weight. In the latter year there was a fall of 7s. 6d. per cwt. between June and November.

These changes call for some careful consideration. In certain areas, distant from the centres which consume their produce, the low autumn prices have been the cause of charges of profiteering against dealers and intermediaries, whereas it appears that the dealers' gross profits per head are often lower in the time of heavy than of low supplies. Their general profits, or earnings per week, may be higher because of larger numbers and lower costs of handling. Apart from marketing, however, these changes call for a reconsideration of productive processes.

Fat cattle have been produced under varying conditions, in different forms of combination with other farm enterprises, and sometimes as the main product, especially of grass farms, under the various circumstances of farming over the whole country. All the pre-war systems are followed, but the extent to which the grass and the stall feeding are each followed has shown considerable changes. The increase in grass fattening is marked, and the decrease in yard or stall fattening is important. The change in the balance of supplies is bringing the whole industry nearer to the grazier system as regards time of marketing than it has been for many years. In some of the grazing districts of the Midlands some 20 per cent. of the cattle go to market in the first half, and

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[3] The comparison of price indexes for beef and for general agricultural produce is :—

	Fat Cattle.	*General agric. products.*
1911-13	100	100
1920	263	292
1921	227	219
1922	163	169
1923	151	157
1924	153	161
1925	151	159
1926	141	151
1927	127	144
1928	138	147

about 80 per cent. in the last half of the year. Indeed, in some years 90 per cent. of the supplies are marketed in the second half of the year.[4] On the other hand, some markets in arable areas have shown proportions of 80 to 85 per cent. of total yearly marketings in the first half of the year, and 15 to 20 per cent. in the latter half. These represent the extremes of the "grazier" system of summer fattening and of the arable system of yard or stall, winter fattening. There are other districts which show more regular production, but most districts lean towards one or other of the extreme systems.

Although the systems of producing fat cattle vary in different parts of the country, and in connection with different systems of farming, the supplies fall into three main classes :—

1. Yard or stall fed cattle from the middle of January to May, and, in some part, to June.
2. Grass fed cattle from late June or early July to the beginning or middle of December.
3. Grass fed, and yard or stall finished, from the beginning or middle of December to the middle or end of January.

These periods vary somewhat from year to year according to the weather and the condition of the pastures, supplies of feed, and also somewhat according to the state of the trade. There are usually some grazed cattle, finished with the aid of concentrates on grass, in the markets in June, and sometimes a few appear in May, but supplies are not heavy until July. The grass fattened beasts, more properly speaking, are on the market from July to the end of September. From that time onwards the better finished beasts going to market have been finished with the assistance of concentrates. A good many comparatively unfinished beasts have been marketed in October of recent years. In November some beasts are still going to market from the pastures, but if in anything like finished condition they have received considerable allowances of concentrates. A number of beasts of this type continue to go to market in early December. Some of the comparatively unfinished beasts are bought for slaughter in November. But in late November some beasts which have been taken from pasture in good condition and then finished in yards or stalls begin to go to market, and this supply increases throughout December. Most of the beasts in the Christmas markets are stall fattened, but some are fattened on pastures with the aid of considerable supplies of concentrates. From the Christmas markets onwards to May the whole of the supplies are yard or stall fattened. Dividing the supplies approximately in this way, the following proportions are obtained :—

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[4] Compare Davies: Grass Farming in the Welland Valley. Oxford, 1928, p. 54.

	England and Wales.			*Grazing district.*	*Arable district.*
Periods.	*1906-13*	*1920-25*	*1926-27*		
December and January	17.3	16.8	17.1	8.8	10.3
February to June	43.7	39.1	37.8	16.5	75.4
July to November	39.0	44.1	45.1	74.7	14.3
Year	100	100	100	100	100

In considering these changes and their causes it is necessary to remember that yard and stall fatteners, especially those of some arable districts, were dissatisfied with financial results before 1914 and during the early years of the war. But it is also essential to realise that the changes have had a considerable effect on the balance of considerations between the grazing and the indoor fattening, or as between winter and early spring, and late summer and autumn supplies. For those fatteners who have facilities for early summer production, up to the beginning or middle of August, the position is still relatively good. For such producers of beef on grass as have to expect to make their heaviest sales in late August, onwards to September and October or November, the position is becoming serious. On the other hand, the relatively high premium on supplies during the late winter and early spring is offering greater inducements to production for sale at that period.

On the farming side, the causes of changes are of a complex character. Fifteen years ago producers were considering with some anxiety the increasing cost of growing root crops, and the often unsatisfactory results of the process of growing roots, fattening cattle by the aid of roots and some straw, and making farm-yard manure for carrying on their arable systems. The relative shortage of concentrated feed, the necessity of growing and the necessity or advisability, sometimes compulsion, of selling corn[5] during the war period accentuated the tendency to restrict winter production of beef. Since 1920 the following factors have been in evidence : Relative scarcity and dearness of labour ; the technical possibilities of maintaining fertility and condition of soils with less farm-yard manure; diminution of acreage of root crops and corn crops, and generally of the area under arable cultivation. On occasions prices of stores have been high in relation to prices of beef.

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[5] See *Journal of Ministry of Agriculture*, Vol. 24, No. 11, February, 1918, p. 1180.

The profits or losses of winter beef production have at times been dependent upon the values of manurial residues embodied in and realised through the sales of subsequent crops. There have been few records of costs of the commercial processes of winter beef production, although records of costs under experimental conditions are obtainable, and a number of estimates have been made on the basis of conventional values. With regard to costs, it is quite clear that there can be no valid or useful interpretation of costs or of financial results of yard or stall feeding without careful reference to the period of selling. With considerable variations in price per cwt. live-weight between December and June there are possibilities of considerable variations in profits or losses on the same basis of costs for different bunches of cattle.

Conditions in the store cattle market are changing from time to time. Relative shortage of store cattle in relation to the demand for fattening purposes, arising from conditions of pasturage or feed-supply on the farm, or the prospects for beef in the markets, necessarily raises store prices, and lower prices necessarily result from the opposite conditions. The feeders' margin—between the price per live-weight cwt. of stores and the live-weight cwt. of fat beasts—varies from time to time; but profits are not alone dependent on this margin, because indoor feeding costs vary from time to time. Yet while the price of the store beast represents 70-80 per cent. of the costs of beef production, this price is bound to exercise considerable influence on the results. So it is important to notice that in recent years relatively high prices have ruled for stores in the months in which they are purchased for pasture fattening, and relatively low prices in the months in which they are purchased for yard or stall fattening.[6] During recent years prices of stores have been relatively high in the months February to May, reaching the highest point about April; and these prices have been low from August to the end of the year. When more beasts were fed indoors there was a tendency for store prices to rise in October or November, although this rise was not equal to that which occurred in April or May. The following figures illustrate the point:—

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[6] See Davies: Grass Farming, p. 59.

Average monthly prices of first and second quality Shorthorn and Hereford store cattle.

	1913.	*Mean of 1926 and 1927.*
	£ s. d.	£ s. d.
January ...	15 3 8	18 4 8
February ...	15 2 6	18 14 8
March ...	15 8 9	18 11 10
April ...	15 15 6	19 1 10
May ...	16 5 9	18 8 3
June ...	16 0 0	18 2 8
July ...	15 8 9	18 1 1
August ...	14 16 9	18 1 3
September ...	14 17 9	17 5 7
October ...	15 6 0	16 14 4
November ...	15 4 9	16 11 7
December ...	15 1 0	16 8 8

With the movements in prices of stores in favour of the autumn buyer and those in prices of beef in favour of the seller· in the spring, while movements are against the buyer of spring stores and the seller of autumn beef, there appears to be reason for a re-examination of the policy of reducing indoor production of beef. In any case, the pressure of graziers on the spring store market has a considerable effect on the profits of pasture fattening.

As regards the connection of indoor fattening with arable cultivation and cropping, it should be noticed that the proportion of total cultivated land under annual crops is now about the same as in pre-war years. The percentage of total cultivated area under annual crops has varied—1910, 31.8; 1913, 31.6; 1920, 36.1; and 1927, 30.7. Yet the total of annual crops has been reduced. While this reduction was bound to have a little influence on indoor fattening, it does not wholly account for the change. The reduction in the root crops, especially turnips and swedes, is perhaps more important than the general reduction in arable cultivation. This reduction has assumed considerable proportions, but with the more recently acquired knowledge of feeding, and the low prices of feeding stuffs in 1925-26 and 1926-27, it might have been expected that there would have been some counteraction of the reduction in supplies of roots. On the other hand, the prices of fat cattle were very low in those years and the industry was generally in a poor state. With improved prospects for beef prices generally, and especially for prices February to June, there are possibilities of more indoor fattening.

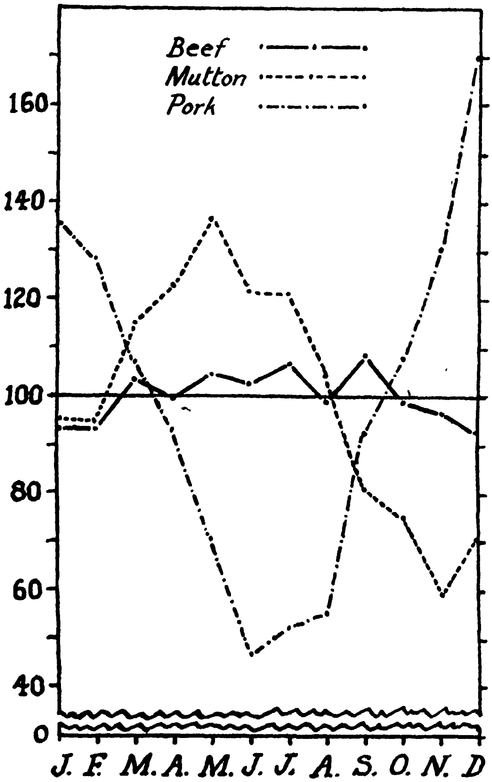
As regards competing supplies, the position is again complex, but it is fairly clear that the changes in seasonal prices, and especially the autumn slump, arise more directly from the conditions on British farms rather than from the effect of competing supplies.

Imports of mutton have been little, if any, heavier in relation to population than before the war and the total supplies of mutton per head have been reduced.

Imports of fresh pork have not undergone any considerable changes likely to have any appreciable effect on the seasonal demand for beef. Total supplies of pig meat have been showing somewhat their usual variations, but in recent years supplies have been inclined to be heavy and consumption appears to be increasing.

DIAGRAM 4.

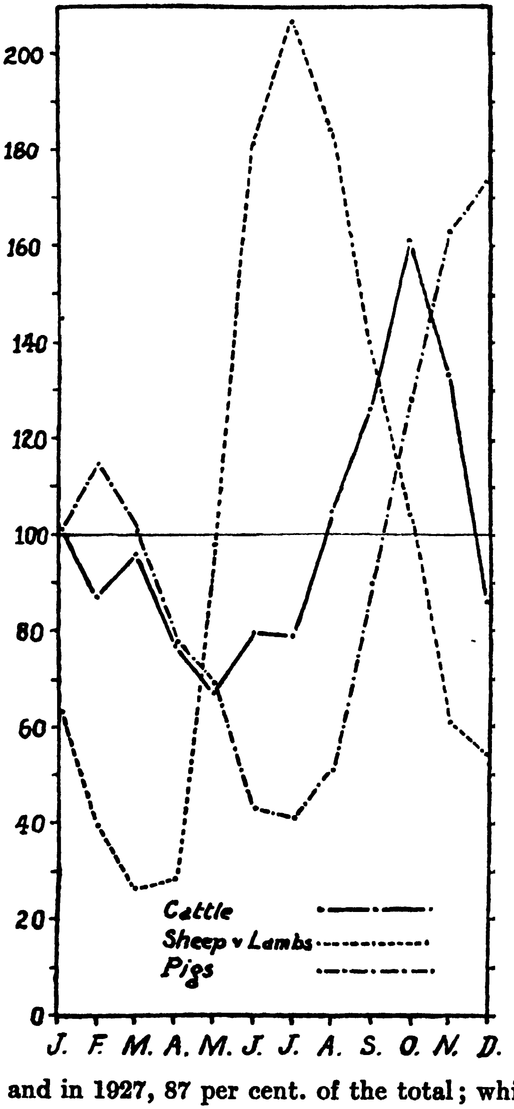
Monthly imports of beef, mutton, and pork, 1920-26. (Deviation from mean).



Imports of beef have shown a very considerable increase, and in 1926 were higher per head of population than in any previous year. The " meat war " of 1926-27 had a considerable influence on prices by increasing both supplies and competition. On the whole, total supplies per head of population have been heavy, and consumption has increased until within the last two years. But the change which has had the biggest and most lasting effect is the reduction, almost the disappearance, of the imports of "frozen" beef, and the increasing supplies of the "chilled" variety. In 1920 the "chilled" carcases represented about 9 per cent., and in 1927, 87 per cent. of the total; while the proportion of "frozen" carcases has fallen from about 90 to 13 per cent.

DIAGRAM 5.

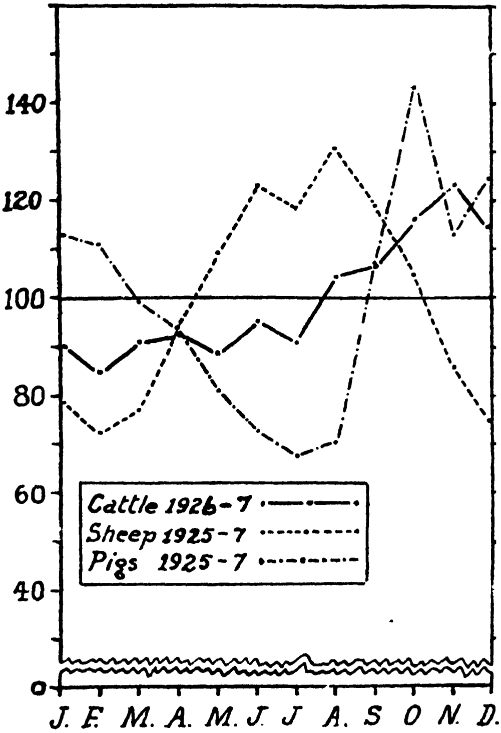
Monthly imports of live cattle, sheep and lambs, and pigs, 1924–26. (Deviation from mean).



While heavy quantities of imported beef are landed in July and September, they go into storage and are not necessarily released, especially while low prices are ruling. The imports of beef show less variation during the year than the home supplies, but the quantities landed during the winter months are generally low (Diagram 4). The heavier imports in September may and probably do have some psychological effect on prices, even though they are not released. And the general effect must be that of weakening prices. The seasonal changes in prices of Argentine "chilled hindquarters" are similar to those in prices of English, but Argentine "chilled forequarters"—the cheaper part—sometimes show slightly different movements.

DIAGRAM 6.

Monthly supplies of fat cattle, sheep and pigs.—England and Wales. (Deviation from mean).

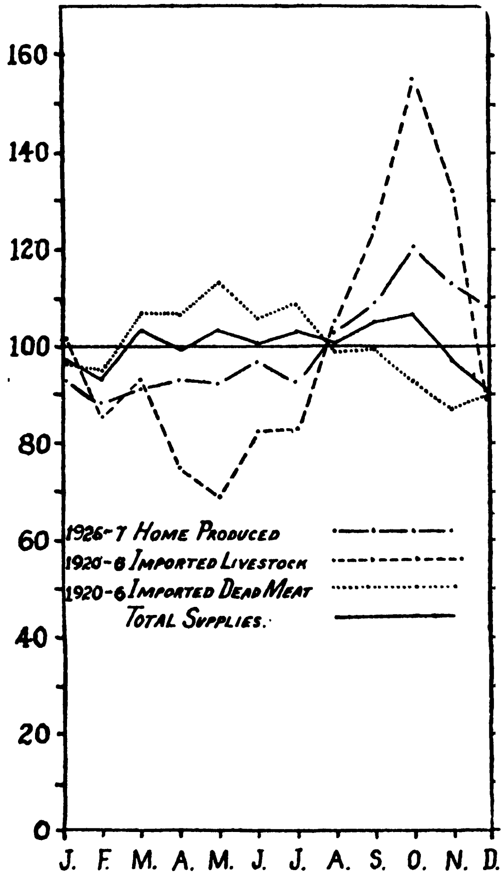


Imports of live cattle, on the other hand, have a direct effect on the market for English supplies. These cattle originate in Canada and Ireland, but supplies from Canada have been very small and the supply mainly comes from Ireland. The numbers are relatively large from August to October and November, when home supplies are heavy (Diagram 5).

Since 1922 total supplies of beef, mutton and pork per head of the population have been heavier than in pre-war years, but were only a little higher in 1926. While mutton supplies decreased until 1924 they have since showed a little increase. The total increase is due chiefly to increases in beef supplies. The increased market offerings have been taken by the consumers, in spite of poor conditions of employment and wages, mainly because of the relatively low price of beef[7]—and of lower prices of pig-meat in the years in which supplies were heavy. The demand for beef has been well maintained, and although the maintenance was partly a matter of price, the fact of maintenance, even increase, is itself important. With the lower imports of 1928, and prospects of lower imports than in 1925-27, there are prospects of improving prices; and the demand will almost certainly be sufficient to take up the supply, even at higher prices.

DIAGRAM 7.

Monthly supplies of all meat from various sources and aggregate monthly supplies. (Deviations from mean). Based on dead weight.



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[7] See below on working-class demand.

On the demand side the position is intricate and evidence is weak as regards some phases. Other meats—lamb, mutton and pork especially—are both supplementary and competitive to supplies of beef. In the early months of the year it may be said that under the conditions existing in recent years, the home pork supplies have been supplementary to the beef supplies; but from September onwards pork supplies are definitely competitive with beef (Diagram 6). The supplies of lamb and mutton from home sources are usually high from May to October and highest June to August (Diagram 6). Imports of sheep show similar movements (Diagram 5). Imports of frozen lamb and mutton are heaviest February to August, but these again go into storage and are not necessarily released on arrival (Diagram 4). The total supplies of beef, lamb and mutton, and pork, show comparatively little variation from month to month (Diagram 7); but they are higher May to October than in other months. The lower supplies in the early part of the year coincide with lower supplies and higher prices of poultry, etc.

With certain classes of consumers all these meats are competing to some extent with supplies of poultry and game. But for the great mass of consumers the meat supplies are obtained in the form of beef, mutton, and pork. The normal demand for each varies to some extent from month to month, but especially between winter and summer. Pork sales are low in summer months, and beef sales fall off with the hot weather. At this time the increased demand for mutton takes up the coinciding supplies. But demand varies somewhat according to the "class" or social status, and the income, of the potential buyer or consumer. People with the lower incomes purchase relatively small supplies of mutton. They may at times be heavy buyers of pork, but their more stable demand is for beef, and, at the lowest incomes for the lower priced qualities.[8]

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[8] Compare Short : The Butcher's Shop. Oxford, 1928, pp. 25-29. It is known that English farm workers, for instance, purchase very little mutton. Most of the meat purchased is beef. In 1903 it was ascertained that the consumption of meat by the working classes varied with income.

Income.	*lbs. of beef, mutton, pork and bacon.*	*Cost.*	*Value per lb.*
		s. d.	d.
Under 25s. ...	7.42	4 8¾	7.65
25—30 ...	8.24	5 7¼	8.16
30—35 ...	9.88	6 11¾	8.48
35—40 ...	9.89	7 1½	8.65
All incomes ...	9.10	6 3¾	8.32

Continued at foot of next page.

The total effective demand for all these three meats is partly dependent on prices and the incomes of potential buyers. Rates of wages, and employment conditions, especially the ratio of unemployed to total workers, have an obvious effect on demand. But with any given set of general economic conditions the relative demand for beef, mutton, or pork (apart from seasonal changes mentioned above) is dependent on their relative prices. With poor economic conditions, the comparison of relative prices becomes more important. Much more information is needed on consumption and consumers' preferences and especially on the points of substitution at different price levels. There is, however, no indication of any change on the demand side which would account for the seasonal changes in supplies of beef noted above; or, at present, of any such change as would account for the autumn slump in beef prices.

From the evidence available it appears that the autumn slump in beef prices is due to the combination of (1) a glut of home-produced beef; (2) imports of " chilled " which are heavier than the normal monthly quantities; (3) increase in pork offers and purchases; (4) the arrival of game on the market and supplies of poultry at lower prices. The glut of English beef is the chief of these causes and certainly is the chief new factor in the situation. Supplies of poultry may be expected to go on increasing to some extent. But during the next two years supplies of pork may be expected to diminish.

There are, however, some points worthy of special consideration. In view of improving qualities of chilled imported beef it is somewhat dangerous to allow supplies of English to go to a

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Continued from previous page.

(British and Foreign Trade Cd. 1761, 1903, p. 212; see also p. 235). The following conditions were found during the period of war:—

Weekly estimates of meat consumption of a "standard family", June, 1918.

Class.	*All meat.*	*Cost.*	*Value per lb.*
	lbs.	s. d.	d.
Unskilled ...	7.69	13 0	20.26
Semi-skilled ...	8.33	14 5	20.77
Skilled ...	8.33	14 8½	21.18
Working class general ...	8.33	14 4	20.65
Clerks ...	—	14 0	—
On Service ...	6.04	10 3	20.36

(Cd. 8980, 1918).

very low point in the months in which there is a comparatively *good demand for beef.* The scarcity of English in the early months of the year is bound to send some potential buyers to the imported " chilled " supplies. All may not return to the English supplies as readily or as rapidly as may be desirable when these again become plentiful.

Then when the autumn brings plentiful supplies of English beef, and low prices in primary and wholesale markets, the retail prices often remain at a relatively high level. Retailers do not vary prices for short periods—even for such periods as two months —in direct proportion to changes in wholesale prices. A lower retail price for English beef in the autumn would help to clear supplies more rapidly than has been the case in recent years. But it would not alone solve the problem of the glut and the slump in primary markets.

Producers and dealers could improve the position by keeping off the market considerable numbers of unfinished and relatively unfinished beasts during September, October, and November, but especially during the latter months. It would be better for the trade as a whole if many of these beasts could be retained on farms for proper finishing. And it would pay some producers to keep their own, or buy other unfinished cattle, and put them into better condition for the market. Some operations of this character in recent years have yielded satisfactory results.

The increasing supplies of " stores " in the form of draft cows from the dairy herd have also some effect on the autumn slump. Fairly large proportions of these go to the fattening pastures in the spring and go off in the autumn. Wherever possible, it is advisable that fat cows should be marketed either in November, or between the end of January and the middle of June. It is bad for the general market to have them on sale between August and October.

On the whole, it appears that there are now many matters in the fat cattle industry which deserve reconsideration in the light of recent changes in supplies and prices. Improving the quality of cattle will not bring its due reward if the younger and better quality beasts tend to go to market in the " slump " period. Changes in supplies have deepened the autumn depression and raised the premium on prices in the spring markets. They have also altered the balance of prices of stores. An increased spring supply would go on the market when total supplies of meats are relatively low, and would probably be taken up without any considerable reduction of the recent price-premium on spring supplies.

II. Effect on Welsh Cattle production.

Farmers who fatten cattle in Wales have recently suffered under the general conditions which have been described. There are occasionally some local market variations from the general movements, but these are of minor importance. Graziers, especially of North Wales, who sell cattle in the English markets have always to meet the conditions described. Even those who are producing for local markets in the summer and autumn have personal experiences of the effects of general changes. Indeed, in some parts of South Wales the autumn depressions have at times been deepened by the conditions in local consuming markets.

In parts of Wales there are special reasons why existing opinions of indoor fattening should be re-examined in the light of recent developments. The supply of store cattle is at hand; and particularly low prices have been ruling in some districts during the later months of the year. The reduction of arable land, and the reduction of the area of root crops, has not always brought the economies which were expected. A return to more plough land, and possibly to larger areas of roots, is worthy of consideration. Winter fattening has continued in some districts, and sales during the early part of 1927 and 1928 apparently gave fairly satisfactory results.

The raisers of store cattle have suffered to some extent from the change of feeders' policies, and particularly as regards the demand for stock and prices in the autumn. Those store raisers who have depended on selling a part of their annual production in the period September—November, but mainly in October, have had difficulty in finding buyers in recent years. In some localities the demand was particularly slack in 1926 and 1927. The cattle sold at this period are usually about 2½ years old, and have been intended for the use of yard or stall feeders. But the producers of younger stores who have relied on selling at this time of the year cattle of about 1½ years have also suffered from poor demand and low prices. Again, dealers have been blamed and there is a common opinion that they take advantages of circumstances unduly to depress prices. Some of these cattle, 20 to 24 months old, have gone to the fatteners. But whether for immediate fattening or for keeping for a further " store " period, store cattle have been meeting a poor autumn demand.

It may be said, on the other hand, that the relatively higher prices of stores in spring have been advantageous to producers. This, of course, must be true in the case of the younger cattle, but it is not true of the older animals, many of which are too old in the following March to meet the best demand or make the best prices. In any case, the advantages of the higher prices in March—April only accrue to those farmers who have good facilities for " wintering ". The raisers of the 18 months cattle for autumn sale are not usually in this position. They have either to change their system of breeding (period of calving) or to arrange the general cropping and stocking of the farm to enable them to " winter " their stores, or to sacrifice them at such prices as are obtainable.

As regards the 2½ year old cattle there is no alternative but to decrease or cut out the supply, unless the feeders' demand increases. In some cases the store-raisers could fatten more beasts on their own farms, but this would not remove the whole difficulty.

There are possibilities of increasing the proportion of cattle fattened on Welsh farms, especially those which reach the age of 18-24 months in the autumn. But there is general need of a reconsideration of the period of calving in the breeding and store raising herds.

Although there may be what is described at a " natural tendency " for cows to go to service in the early summer and to calve in the spring, this is not inevitable. Welsh herds kept for producing milk for immediate sale show the following distribution of their calvings :—

Period of calving: milk producing herds.

	March-May.	*June-Aug.*	*Period March-Aug.*	*Sept.-Nov.*	*Dec.-Feb.*	*Period Sept.-Feb.*
	%	%	%	%	%	%
Group 1	24	20	*44*	27	29	*56*
Group 2	24	19	*43*	22	35	*57*
Group 3	21	21	*42*	36	22	*58*
All groups	23	20	*43*	26	31	*57*

The position in the breeding herds is somewhat different. The times of service and of calving are shown in Diagram 8, where it will be seen that there is a low supply of calves July to November. The July—August supply is necessarily, and probably advisedly, low; but there is opportunity for increasing the supply October to January.[9] As breeding is now arranged it results in fairly heavy supplies of two-year-old stores each spring, in some districts supplies of 2½-year-old cattle in the autumn; and in other districts supplies of 1½-year-old in the autumn. It is suggested that a supply of forward stores of 18-20 months of age in the spring would meet a ready demand, and that a supply of stores of two years or thereabouts in the autumn would also find a better market than has been realised by the older and the younger cattle in recent years. While the spring demand for stores continues, Welsh farmers have to cater for it, but if the tendency towards using young stores continues they will be bound to consider the management of the herds in respect of period of calving.

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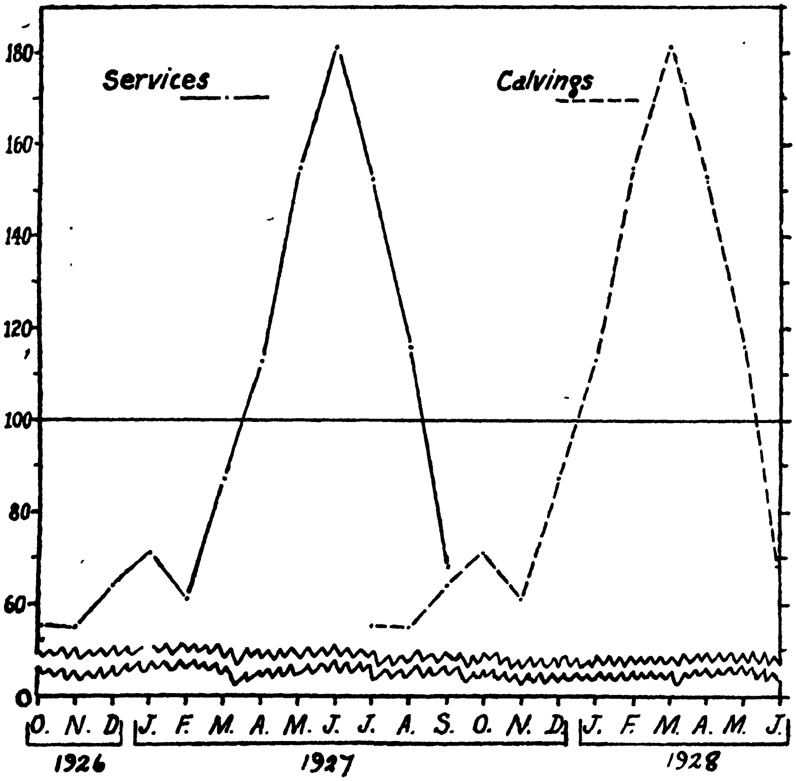
[9] For another discussion of this subject, see Ashby. Economic Conditions in Welsh Farming, Aberystwyth, 1928, pp. 19-24.

DIAGRAM 8.

Distribution of services and calvings in Wales. (Deviations from mean).



General Note. SOURCES OF DATA AND BASIS OF CHARTS USED. The data for Charts 2, 3, 4 and 5 were obtained from the *Agricultural Statistics* and *Market Reports* published by the Ministry of Agriculture. The supply curves are based on the numbers of livestock entering representative markets in England and Wales and in each case monthly averages for a number of years were calculated. In order to eliminate inaccurate representation of supply which would arise out of the inclusion of months representated by five week periods, the average weekly supply for each month was calculated. The price curves represent the average monthly price of Shorthorn cattle for a stated period.

Charts 6 and 7 are based on data extracted from the *Monthly Trade Returns* published by the Board of Trade, and represent the monthly averages for the period stated.

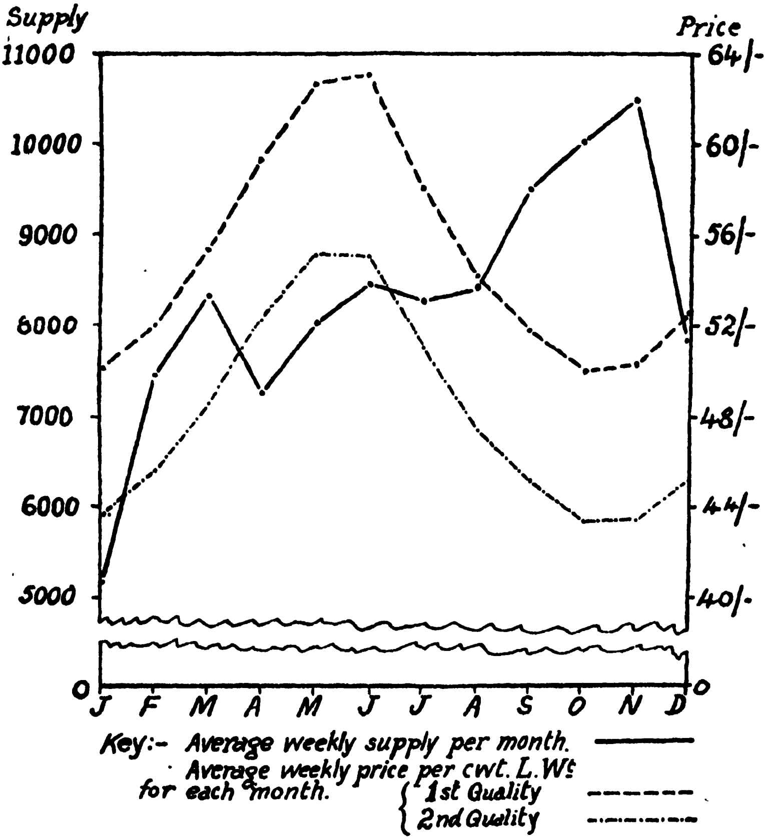
Chart 8 is based on the above data, but in all cases live animals were converted into dead weight, the following conversion factors being used:—

Cattle ... = 628 lbs. carcase weight.
Sheep and lambs = 52 lbs. ,, ,,
Veal ... = 87 lbs. ,, ,,
Pigs ... = 160 lbs. ,, ,,

Each curve in this Chart represents the combined supply of each kind of meat, i.e., beef; mutton and lamb; and pig meat; for the periods stated.

APPENDIX.

Supply and prices of fat cattle, England and Wales, 1928.



THE MARKETING OF CATTLE IN WALES[1]
(WITH SPECIAL REFERENCE TO NORTH WALES).

By **Thomas Lewis**, B.Sc., M.S.,
University College, Aberystwyth.

The cattle industry of Wales is largely controlled by the topography of the country. About 37% of the total area used or useable for agricultural or pastoral purposes is composed of exposed Mountain and Marsh land. It is classified as poor quality rough grazing. The remaining 63% is of a very mixed character, and much of it is comparatively poor land. Two other factors to be mentioned are, firstly the heavy rainfall which tends to encourage pasture farming, and the size of the agricultural holdings found in Wales. Of these 69% are below 50 acres in size, 88% are below 100 acres and only 12% of the holdings are above 100 acres in size.

The nature and quality of the herbage and its variety, together with the factors already quoted, have had a large influence on the development of the cattle industry in the past, and continue to exert a large measure of control over it at all times. The approach to the problems of marketing must always be made by bearing in mind that the characteristics of production on the farm, the natural forces, the customs and sociological forces have moulded, and do mould and control the industry.

Store Cattle.

For a very long period Wales has been an exporter of store cattle into English grazing districts. Some cattle have been fattened for local consumption, and the remainder have been sold as stores to go over the borders into England. In pre-war years, as far back as the end of last century, there is evidence that cattle were fattened for "export" to a small extent. These were invariably winter fattened, heavy cattle for the Midland and London markets.

Welsh stores have held a high reputation for quality, hardiness, and thriftiness in English grazing areas, and still continue to maintain their reputation, but the needs of the English graziers have already changed materially, and still continue to change.

Since the war, the store cattle trade of Wales has rapidly declined. To a small extent the change may have begun before the war, but it was undoubtedly the war period that firmly established the change in practice. During the war, Wales discovered that there was a large potential demand for a type of unfinished fat cattle in the thickly populated industrial area of Lancashire. These may be described as three-quarters fat or a little better, and characterised as lean beef. There are large areas in most Welsh counties which are capable of producing this class of beef on grass land. With the laying down of arable land to grass which has been proceeding since the war, a proportion of the additional grass land has been devoted to the production of grass beef, and this partly accounts for the decline in the supply of store cattle for the English markets.

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[1] This paper was read at the National Conference on Cattle Breeding and Marketing organised by the Welsh Department of the Ministry of Agriculture and held at Aberystwyth in November, 1928.

From the point of view of cattle production, Welsh farms can be classified into three groups.

(1) Small holdings producing a few calves each year and selling them in the autumn as yearlings.

(2) Larger, and sometimes fairly large farms on poor grade land, rearing about two calves per cow kept, buying yearling stores from small holdings and running them over a second winter. In some cases these are sold in good meaty condition and make excellent "graziers' cattle", in other cases they are sold in poor condition, forming a class unsuitable for the stronger Midland pastures, but which find a market on the weaker pastures of the North Midlands. A large number of these two to two-and-a-half year old cattle are sold in the autumn either locally or for export to the arable areas of the Eastern Counties. The main bulk of the two-year olds are, however, sold in spring.

(3) Another class of farms, including various sizes, which have a high proportion of good grass land. Many of these have changed their system from selling store cattle into feeding them on grass during the period April to October.

These farms rear about one calf per cow kept, and rely on a supply of good meaty stores from store producing farms. Relays of stores are bought at intervals throughout the summer, and some large grazing farms may sell 200—300 fat cattle during the season. In many cases some concentrates may be used throughout the summer to supplement the grass. Whilst on the best land concentrates may only be used during the latter part of the grass season and for finishing for the Christmas market.

The predominance of the dealer system. The dealer system in Wales is an ancient institution which still thrives. There is a large internal trade in store cattle in the Principality. A proportion is carried on in every local district, and again there are wide movements between counties and distant areas. At present, by far the larger proportion of store cattle are handled by dealers.

Three classes of dealers can be distinguished.

(1) Purely local dealers handling all classes of store and dairy cattle. Their operations may be limited to local districts or by county boundaries. In the main they are local farmers, or alternatively holders of a number of separate parcels of accommodation land.

(2) The second class of dealers handle dairy cattle. These are external people, mainly from Cheshire and its borders.

(3) Dealers in fat stock. These are again local people, being either farmer-dealers or purely dealers holding accommodation land. These dealers confine their activities to buying fat stock for export to English markets.

Our modern economic system is relied upon to provide a service wherever there is a need of it. But established methods of rendering services go out of date, or become cumbersome and inefficient, and there is no method of preventing the continuation of a system which may be superfluous to any real want if there is an element of monopoly operating. There is an element of strongly entrenched personal relation, if not of monopoly, in the Welsh dealer system. To consider the position of Wales it is necessary that the six counties of the North should be clearly distinguished from the seven counties of the South.

The Northern Counties are mainly agricultural with a human population of about half a million. On a rough estimate based on statistics collected for North Wales, about three-fifths of the net livestock production is exported to English areas.

In South Wales on the other hand, where there is an industrial population of nearly two and a quarter millions, there is a local market for its livestock. There is some export from parts of South Wales, notably Brecon, Radnor, and South Cardigan, but on the other hand some fat cattle are drawn from the English border areas.

Naturally in North Wales there is the need for some form of organisation to mobilise, transport and sell livestock on distant English markets. Whereas in parts of the Southern Counties the contact through auction marts between farmer and retail butcher is fairly close. In some of the more isolated parts of South Wales the dealer system is strong.

The consequence is that in the North the bulk of the cattle trade is in the hands of local traders, and the development and growth of auction markets has brought about an increase in their numbers. Two factors appear to have contributed to the increase in numbers of dealers since the war.

(1) The increase in numbers of auction marts and a resulting decrease in the average offer of stock per market.

(2) The post-war depression and the difficulty of making a living on the farm, together with the opportunity presented through the development of auction marts, have induced many farmers to resort to dealing. This system may be described as " trying to live by doing each other's washing ". It may be good for certain individuals, but it is bad for the cattle raisers as a group.

In one county there are as many as twenty-five dealers handling the export cattle trade, and correspondingly large numbers in others, apart from a large number of smaller local dealers. There is a tendency in recent years for farmers in general to resort to dealing whenever it is possible to do so, believing, and possibly rightly so from an individual point of view, that this is one of the few methods of making a living under present conditions, but forgetting that whatever the gains obtained in this way, they have to come from the agricultural industry at some point or other.

The faults of the dealer system. The faults of the dealer system in North Wales arise out of its economic strength in contrast to the economic weakness of the farmer.

By professional arguments, psychological knowledge, personal contact, business acumen, knowledge of the trade and prices, established connections, the dealer makes his way; while performing such services as the collection of stock from the farm, and saving the time which the farmer and his men would require to attend an auction mart. In general, the buyer's arts developed to a high degree place the dealers in a very strong position, especially as they co-operate very effectively in their own interests in order to eliminate competition.

The farmer in contrast is forced to sell at periods controlled by conditions on his farm and financial necessity. He has little knowledge of the trade and prices, and often if he is not induced to sell through the persuasion of the dealer, his urgent financial needs force him to sell. Also the farmer is in severe competition with his neighbours. There is no attempt made by farmers as a class to eliminate this weakness by organisation or co-operation.

Again, it is often the case that whether the farmer takes stock to the auction mart or sells it at home, he has to sell to the same dealer and can only extract the same terms. In either case he believes it is an advantage to save the auctioneer's charges and his own time by selling at home. Dealers are in close association with one another, and in North Wales the "pitching" of markets and country areas is common practice. (Pitching is the system of allocating markets or country areas between themselves and limiting the number of buyers in each market or district.) In many cases competition is largely eliminated. Butchers are usually allowed their choice in markets, but when their requirements are met the remainder of the trade is in the dealers' hands.

Dealers are far too numerous for the amount of trade to be done in most parts of North Wales, and the dealer system is both unsatisfactory and expensive, as it operates at present in view of the depressed conditions of agriculture. This criticism is not directed towards the legitimate and efficient dealer system which has its proper place in livestock marketing, but against the particular system as it operates in Wales at the present time.

Auction marts and duplication of sales agencies. Auction marts have sprung up with amazing rapidity since the war.

As far as can be ascertained the following number of sales were held in the given counties last year. These figures account for cases where two or more auctioneers sell the same class of stock in the same market at the same time, as separate sales.

Market Centres, number of Auction Marts, number of separate Auction Sales per week for 1927.

County.	*Number of Centres at which Auction Marts are held.*	*Total number of Auction Marts held in 1927.*	*Number of sales held by Auctioneers.*	*Average number of Sales per week.*
Anglesey	10	388	388	7— 8
Caernarvon	18	160	167	3
Merioneth	11	163	163	3
Cardigan	10	278	278	5— 6
Denbigh	19	399	558	10—11
Flint	5	194	197	3— 4
Montgomery	11	239	258	5
Monmouth	9	238	550	10—11
Total	93	2,059	2,559	49—50

The average, small local auction mart found in most parts of Wales has all the disadvantages with none of the advantages of auction selling as far as the farmer is concerned. There is too much duplication of sales agencies, to the detriment of both farmer and auctioneer. The present system is almost as bad for the auctioneer as for the farmer. Often he only gets the dregs of the market for sale under the hammer, and his capital, time and organisation are to some extent superfluous or wasted. When two auctioneers offer to do the work which might well be done by one, the possible buyers are divided, and the essential elements of full publicity and free competition are absent. The auctioneer does not get full reward for his efforts and the farmers' interests are not protected as they ought to be under the auction system.

Export and lines of travel. Few store cattle under two years old are exported from Wales. The number rarely exceeds 10,000 or falls below a thousand. Very occasionally there may be a deficit of cattle under two years old and a few may enter the country. Almost the whole of the store cattle sold off farms in Wales are two years old or over. The demand for this class is very seasonal, sales being heaviest in early spring. In September and October some stores are exported to the arable districts of the Eastern Counties of England for winter feeding. The other types of demand being for graziers' cattle from areas extending from Northamptonshire and Leicestershire to Warwickshire and Worcestershire. There is also a demand for Welsh stores in parts of Yorkshire.

There still remains a good demand for good quality Welsh Runts in the English Midlands. In the Eastern arable districts there is a better market for shorthorn cattle. The poorer classes of Welsh stores are mainly sold into the North-Midlands and Yorkshire.

The supply of Welsh stores available for export has been diminishing appreciably over a long period, as more cattle are being prepared for the final market within the country. One factor responsible for the fall in the export of stores is the practice of selling more cattle for immediate slaughter, and this appears to be the most important. Another factor which has caused a fall in store cattle exports for feeding purposes is a practice which has grown in recent years of getting as many heifers as possible in-calf. There has been a good market for these in Cheshire and the dairying areas on its borders.

Fat Cattle.

With the reversion to grassland which has been proceeding since the war winter fattening of cattle has been diminishing rapidly, especially on the best farms. Although the population of the six counties of North Wales is only approximately 500,000 there is a scarcity of fat cattle for local consumption during the months of February and March. One cannot say that the position is uniform all over the country in this respect however. The poorer farms on the slopes surrounding the Clwyd Valley still maintain their customary acreage of arable land, simply because they are unable to secure good pastures without using the plough, and in such areas winter feeding is still carried on, though not to the same extent as in former years. The proportion of grass-fed to winter-fed cattle for the country as a whole has been increased very largely since the war.

Three tendencies which have been in operation since the war can be distinguished :—

(1) Some small farmers who formerly used to sell yearling stores tend towards feeding their cattle and selling them as lightweight beef at about 18 to 20 months old.

(2) An increasing number of holders of accommodation land, without farms or buildings, fatten cattle on grass during the summer season. All these cattle have to be sold at the end of the year, and as far as possible they are sold as " fat ". Towards the end of the season many are only nominally in fat condition.

(3) The third development is that of a grazier's system, similar to that prevailing in the Midlands, under which cattle and fat lambs are the main products. This system is found mainly in Anglesey.

The majority of producers of fat cattle rely on purchased foods where extra feed is required to supplement pastures; very little home grown foods—roots or grain—being produced for this purpose.

Excluding the more purely dairying areas bordering on Cheshire and the South Wales industrial areas, there are very few draft cows fattened. These are usually exported in store condition for feeding in English areas.

With regard to heifers the tendency has been to sell as many in-calf heifers as possible during the last few years. There has been a good demand for these at better prices than if sold in store condition or fat.

The main supply of fat cattle placed on markets in Wales consists of two to three year old steers weighing from 9-12 cwts., with a small proportion of fat heifers and fat cows.

In markets contiguous to dairy areas a much higher proportion of fat cows is to be found.

Local consumption and sale. There is a good deal of variation in the relations of local supply and demand for fat cattle in Wales. In Anglesey the local slaughtering of cattle is about one-sixth of the total number of cattle sold outside the county. From February to April, however, the local supply is inadequate, and some fat cattle are imported from Dublin.

Many other Welsh counties show a similar late winter and spring deficiency in the local supply, and a large surplus from June to the end of the year.

Conditions in South Wales are again different. There is usually sufficient local demand to absorb the whole of the fat cattle production throughout the " grass fed " season, with a larger deficiency made up from the border English Counties in spring.

The consumption of imported, chilled or frozen meat is comparatively low in North Wales as a whole, but it is estimated that 75% of the beef supply of the South Wales industrial area is of this character.

The sale of cattle for local consumption is largely through auction marts. Though in most parts of Wales, and in some parts to a larger extent than others, farmers supply butchers direct.

Sales to areas outside Wales. South of Montgomeryshire, Wales has an internal market which absorbs its fat cattle production. North of this line the export markets for fat cattle are almost exclusively within the industrial area of Lancashire and parts of Cheshire and Derbyshire. Approximately 20,000 fat cattle were exported from North Wales into this area during 1927. From Mid-Wales a number of fat cattle pass through Oswestry and Shrewsbury markets on to the Birmingham meat market.

By far the most important single fat stock market for North Wales is that of Salford. This is a private treaty market to which about thirty-two dealers from Wales took cattle during 1927. This market is supplied from different sources at different times of the year. During the spring—February to June—supplies are obtained from English arable districts and from Shropshire. Early June to July supplies arrive from South Midlands, the Welsh supply is received July to November, followed by supplies from North Lancashire and Yorkshire almost coinciding with, but a little later than the Welsh supply.

Salford is a dealer-butcher, wholesale market, provided by the Salford Corporation, dealers paying tolls on the number of animals offered for sale. Prices for fat cattle on a given day vary within wide margins according to the variations in the qualities of cattle offered for sale. This market serves a wide area conveniently, and its most obvious drawback is the almost impossible task of quoting the prices made. Quotations have to be collected from three classes of tradesmen—dealers, butchers, and wholesalers. The dealer quotes with a downward bias whereas the other two quote with an upward bias, and the only possible approximation of prices depends on an estimate of an average price based on quotations that may not have been actually made in the market at all. As a central outlet for Welsh fat stock this market is well situated. As a price barometer it is a very poor one to follow, but the only one applicable to conditions in North Wales.

Production and market demand. With regard to the seasonality of supply there again exists a wide variation between counties. The Anglesey output represents typical graziers' supplies from the end of June until January, with no exportable surplus practically in the intervening period.

In Carnarvonshire, with a higher proportion of poor land, there is more winter feeding and only limited areas capable of producing grass beef. Denbighshire again is similar—the best pastures are invariably used for grass beef production, while hillside farms fatten in winter. A large proportion of grass fed cattle produced in Denbighshire are consumed in the seaside resorts on the Welsh coast during July, August and September, with the result that there is not a very high export trade of grass-fed cattle. The Denbighshire supply shows a greater resemblance to Anglesey than that of other counties. Anglesey with its present system of production has suffered badly in having to sell its cattle largely at low price periods. Other lowland areas in North Wales have suffered for the same reason.

The difference between the prices of fat cattle in June, when they are usually highest, and those of October or November, when lowest, has been widening steadily since the war. There are many causes for this, but probably the most important is the change in seasonal supply of home produced cattle.

The only remedy capable of being of any assistance to producers of grass beef is to strive towards a better balance of supply throughout the season. The question of relative costs of summer and winter feeding under existing price movements would have to be considered, but it is highly probable that the necessary adjustment need not make much difference in the factors of cost. It could be brought about by a better organisation of land, labour, and machinery as they exist on the farm.

Suggestions.

Store stock. It is suggested that store stock marketing could be greatly improved through the elimination of a large number of the small local auction marts and their consolidation into a few large regional sales. Selling store stock on approval can never be a success. This is one case where the buyer wants to know what he is buying and where a deputy is never satisfactory.

This consolidation is especially important in the case of spring store sales, and if farmers' organisations could formulate a scheme whereby a series of large regional sales could be organised in succession, it would be possible for English buyers to attend such markets with a reasonable expectation that there will be a sufficiently large number of stock on sale to meet every variety of demand. This method should make auction sales of real service to farmers. It would eliminate unnecessary services of dealers and ensure that at least competitive prices are obtainable by the breaking up of price rings. It would also provide facilities for savings on transportation by offering possibilities of larger shipments.

Fat Stock. The larger proportion of the fat stock of Wales passes over the auctioneer's weighbridge. Selling by auction is as good a method as any, provided such an auction operates in fairness to all parties. One of the great drawbacks to the majority of fat stock sales in Wales is that they are too small, a weakness which is due to the fact that they are held in too many centres and too frequently. There are markets in Wales where three salesmen in the same yard are selling fat cattle at the same time. This process of splitting up buyers, facilitating rings, must react to the detriment of sellers in the determination of prices. Fat stock sales could be consolidated into larger central sales, with undoubted advantage to the farmer.

Another drawback to Welsh auction marts is the presence of a weighbridge with its costs when there is no real criterion by which quality can be related to weight. 112 lbs. live weight means little in the market at present, and this is obvious if any sale is attended and prices and weights recorded.

The Weighing of Cattle Act was expected to bring more order and certainty into the marketing of fat cattle. That it has not done so is not entirely due to the fact that the weighbridge is a useless institution, for it brings at least one item of certainty. The quality of fat cattle is perhaps more important than exact weight, especially as the live-weight condition as to fullness or fasting may vary when different animals are on the scale, so that the dead-weight proportion to live-weight may vary with individual animals within one class or grade. But the suggestion that dealers and butchers have some mystic knowledge of dead-weight proportions and of quality has been emphasised since the use of the weighbridge became compulsory. The best feeders know more of quality and of killing weights than most dealers and butchers will admit, and it is always a part of the buyers' policy to depreciate the seller's knowledge or opinions on these items. Even those feeders who are not regular or constant sellers have some knowledge of the items. They ought to obtain more. There is little doubt that the weighbridge would have been more useful if farmers themselves had not deprecated its use or depreciated its importance, and if they had not entirely accepted buyers' opinions as to their ignorance of quality and killing weights.

A practical scheme of assistance to farmers might be evolved. In districts in which fat cattle of any class are produced in considerable numbers the Agricultural Education Authorities might arrange demonstrations of carcase weights and qualities. Where Public Authorities own abattoirs and farmers would supply cattle, arranging with butchers to take the carcases, demonstrations could be arranged at little cost. The opportunity might be taken to demonstrate correct methods of flaying and of dressing beasts. Cattle producers of all kinds would probably appreciate these demonstrations if they were given with animals locally bred and fattened. By some such method, the weighbridge might be made of service, and such demonstrations might assist in developing the principles and methods of grading the living beasts. The grading of fat cattle, given grades which are clearly defined, generally acceptable to all parties, and uniform for the whole country, would enable producers to obtain the full benefit of the use of the weighbridge. There would be a better understanding of price quotations, which would be based on quality as well as weights, and the innovation should assist farmers both in the production and in the actual marketing process. At present, price quotations convey little information of value to producers.

The first suggestion for a more efficient system for selling livestock is to reorganise auction selling on a larger regional basis; the second, the introduction of uniform grades and uniform price quotations.

Another suggested method would be the establishment of local fat stock shipping associations by farmers for the purposes of the trade outside Wales which must be carried on. These could be formed around convenient railway centres, each society including in its membership farmers from a seven or eight mile radius. One member of the society should be appointed to see to the loading and consignment of livestock, and could be paid for his services.

The success of a scheme of this sort would depend on a large number of such societies being formed to cover a wide area· All the societies could be amalgamated into one selling organisation and a salesman appointed to dispose of stock on the central markets. With efficient committees and close co-operation, such a scheme should serve an exporting area efficiently and at a low cost.

In order to ensure that butchers could obtain their requirements, they could be supplied at mobilising depots as easily as they are supplied at the present time in auction marts.

A third method which would be possible in a county like Anglesey, where there is an adequate supply of stock, is the possibility of establishing a central abattoir for the slaughter of animals and exporting the carcases. The main difficulties here are high capital requirements and the lack of experience in such ventures. The utilisation of offals, upon which probably its success would depend, would also present difficulties.

This may be a future development, but except in such a county as Anglesey, it could not be suggested with great confidence at such a period as this, when farmers are entirely unorganised for business purposes. These suggestions are put forward as deserving of examination and consideration by all those who are concerned in the marketing of livestock. Until farmers as a class are sufficiently organised locally and nationally to act collectively, little progress can be made towards the reorganisation of marketing. When farmers are effectively organised, marketing reform must follow. In any development local aspects must be co-ordinated with the wider national aspects of marketing. Systems which have outlived their usefulness should be replaced by methods better adapted to present requirements, and which are capable of bridging the gap between producer and consumer with the maximum of efficiency.

THE WORK EFFICIENCY OF FARM ORGANISATION IN WALES, 1871-1921.

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The efficiency of farm labour is a subject of great and continuous interest amongst the farming population of Wales. It is discussed on many occasions by all kinds of persons under many circumstances. Although discussions often start with an expression of opinion that efficiency is declining, or that this generation is less efficient than that preceding it, the opinion is not altogether of a "class" character. About half the work on Welsh farms is done by the occupiers and members of their families and the other half or slightly more by paid employees. These employees, however, are often of the same social class as their employers, being themselves descendants of small farmers. The poor opinions of the older folk on the working capacity of the younger generation are therefore opinions that do not wholly or necessarily arise from class bias.

It is only rarely, however, that any clear realisation of the importance of this subject is to be found. In every discussion the point that the nature of farm work and the character of farm organisation is changing is made at an early stage. There is also some realisation of the condition that the efficiency of the worker as such cannot be considered, to any practical ends, without full consideration of the efficiency of management, of the equipment supplied, and of the organisation as a whole. Yet while it is realised that any unit of the whole organisation accomplishes a bigger task than a similar unit of one or two generations earlier there is still a charge, moral rather than economic, that people do not work as strenuously, or as long hours, as formerly. It will probably be a long time before the idea that there is virtue in work itself, and that the harder and longer the work, the higher the virtue, can be excluded from this discussion, for this is an idea that once instilled dies hard amongst a population of small farmers.

The existence, and the persistence, of this idea sometimes excludes from view the fact that recent changes in the organisation of Welsh agriculture have raised the productivity of labour engaged in the industry; and that (without a general rise in the relative values of farm produce) a rising efficiency of organisation, bringing rising productivity per person engaged, is requisite for raising the standard of living of the agricultural population. When an increasing efficiency of organisation cannot be applied in intensified cultivation or to a general increase in production there is bound to be some reduction of the amount of human labour used, and this may take the form of reducing numbers or reducing hours of labour, or possibly both forms. If the material standard of living is to be raised, apart from the item of leisure, then numbers will be reduced.

The outstanding facts in the recent history of Welsh agriculture are :

The reduction in farm population,
The reduction in arable cultivation,
The increase in live stock production,
The increase in importance of capital equipment.

All these have their influence on the nature and the extent of the farming " task " in Wales. All have had their origin in forces and conditions arising outside the organisation of Welsh agriculture itself. But in addition to these direct changes in the industry made and conditioned by causes working in its environment, there are other indirect changes which are of some importance. The chief of these from the point of view of labour and conditions of employment or engagement in the industry have been the increasing productiveness of other industries, the rising possibilities of improving material standards of living, and the shortening of hours of labour. Welsh agriculture has been subject to the influences arising from the competition of other industries for labour not only in the numerical supply of workers but also in rates of wages and customary hours of labour.

The numerical supply of workers at each *Census* period from 1871 (excluding female relatives of farmers[1]) shows the following changes :—

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[1] The figures used in this and subsequent Tables exclude female relatives of farmers and graziers throughout, because the figures for this class are very unreliable. At the Censuses of 1881 and 1891 this class was excluded from the categories of agricultural population. The figures for this class are always so uncertain that interpolation of missing figures would lead to uncertain results. Otherwise, every care has been taken to make the population figures at each Census period truly comparable. The figures for land and stock used in subsequent Tables have been taken from the *Agricultural Statistics*; they represent the yearly average for three years, of which the year of the Census is the middle year, e.g., *Census* of 1871, *Agricultural Statistics*, 1870, 1871, and 1872.

Persons occupied in Agriculture in Wales and Monmouth.

	South Wales (seven counties).	*North Wales (six counties).*	*Wales and Monmouth.*
1871	67,427	49,907	117,334
1881	60,786	45,859	106,645
1891	56,502	44,023	100,525
1901	51,950	41,775	93,725
1911	54,207	42,819	97,026
1921	51,380	40,363	91,743

A measurement of three of the chief changes in the organisation of Welsh agriculture is given in Table I. Unfortunately no direct measure of the increase in capital or of capital and equipment, especially in implements, machinery, and power, except in the case of horses, is now possible. But the general change in farm equipment is well known, and it will be dealt with to some extent at a later stage.

The labour task of the persons engaged in the industry is that of cultivating the land, growing and harvesting crops, attending and managing the livestock, and generally of maintaining the whole farm in a state of fertility and productivity. Table I indicates the changes in the numbers of persons available for the task, and the changes in the task itself. But the task is not done by the unaided work of the persons engaged. It is done with the assistance of capital, in the form of motive power, whether of horse or mechanical origin, and in the form of working implements and machinery. It is also done under managers and organisers—in effect the farmers—who supply the capital in these forms, who combine the capital and the manual labour according to requirements, and to their circumstances, and who also supply the managerial element of organising wisdom and efficiency. The completion of the task is due to the use of the three elements of manual labour, capital in its embodied forms of farm equipment, and " management ". Efficiency in the task is the efficiency of the whole organisation, of the three elements and their combination.

At the same time, it is important that the efficiency of the whole organisation should be measured in terms of efficiency per person engaged. Those engaged in agriculture do not live to work, they work to live; and they are concerned with the results of their work as found in their actual or possible standards of living. Measured in terms of land cultivated and of stock managed the efficiency of the organisation of Welsh farming, as represented by the task accomplished by each person engaged,

TABLE I.

Number of persons and of livestock per 1,000 acres of cultivated land in Wales and Monmouth.

Year.	*Persons per 1,000 acres.*	*Per cent. arable.*	*Per cent. grass.*	*Working horses.*	*Total horses.*	*Cows and heifers in milk and in-calf.*	*Total cattle.*	*Sheep.*	*Pigs.*
1871	41.60	28.17	71.73	26.87	45.01	94.86	227.12	1044.67	84.34
1881	35.26	22.82	77.18	26.10	49.08	91.51	229.75	890.95	71.81
1891	32.26	19.06	80.94	27.17	51.36	99.11	253.42	1087.19	83.07
1901	30.61	16.89	83.11	32.40	54.64	97.70	257.85	1198.84	76.61
1911	32.26	15.67	84.33	33.69	58.13	100.62	264.08	1279.45	78.51
1921	32.27	18.10	81.90	32.22	62.62	112.10	274.79	1191.55	73.88

TABLE II.

Land and Stock Managing Capacity, 1871–1921.

(Acres of land and numbers of livestock per person engaged in Agriculture in Wales and Monmouth).

Period	*Total cult. area.*	*Arable.*	*Grass rotation & permanent.*	*Work horses.*	*Other horses.*	*Total horses.*	*Cows and heifers in milk and in-calf.*	*Other cattle over 2 years.*	*Other cattle under 2 years.*	*All cattle.*	*Total sheep.*	*Total pigs.*
1871	24.01	6.76	17.25	.65	.44	1.09	2.28	1.07	2.11	5.16	25.11	2.03
1881	28.35	6.47	21.88	.74	.65	1.39	2.57	1.27	2.65	6.49	25.26	2.04
1891	30.99	5.90	25.09	.84	.75	1.59	3.07	1.35	3.43	7.85	33.69	2.57
1901	32.66	5.51	27.15	1.06	.73	1.79	3.19	1.11	4.13	8.43	39.16	2.50
1911	31.07	4.86	26.21	1.04	.76	1.80	3.12	1.02	4.04	8.18	39.66	2.43
1921	30.99	5.61	25.38	1.00	.94	1.91	3.47	1.02	4.02	8.51	36.93	2.29

has increased considerably during the last fifty years. Table II shows the acres of land and numbers of livestock for which each person in the industry has been responsible at each of the *Census* periods 1871-1921.

The number of acres of land and the numbers of livestock of different classes managed on the average by each person engaged at each *Census* period express what may be called "the land and stock managing capacity" per person in the industry. But they do not, standing alone, provide an index of the work efficiency of the organisation or of the persons engaged in it. Recent investigations, however, have provided a basis for the making of such an index. Under recent conditions the "hours work requirement" of the chief work units shown in Table II have been as follows :—

	Hours per annum.
Arable land : acre (all arable crops)	103
Grass land : acre (all operations on pasture and hay crops)	9
Horses (1) (all types)	105
Cattle (1) (all types)	78
Sheep (1) (all types)	3½
Pigs (1) (all ages)	54

The average year's work of each person regularly engaged has recently been about 2,409 hours, or about 301 days of eight hours each. This does not imply that work is restricted to eight hours per day or to 301 days : it is approximately the *effective working time* allowing for sickness, holidays, bad weather, and part-time working of the farmers themselves[2]. This time was spent as to three-quarters in direct labour on the crops and stock specified as work units in Table II, and as to one-quarter on other stock such as poultry and on "establishment" or general maintenance work, such as is necessary but cannot be allocated to specific crops or stock.

	Per person per annum.
Labour hours allocated to specific crops and stock	1927
Labour hours, general work	482
Total	2409

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[2] Records obtained from Welsh farms, 1925-27, by a detailed method of recording time worked and work done on crops and live stock gave an average of yearly time for regular workers of 2,480 hours. The farms constituted a representative group, and all kinds of operations were covered. A small sample for 1920-21 showed an average effective working time for regular workers of 2,390 hours per year, or 19 hours less than the figure shown in Table III. (See J. Morgan Jones, *Labour Organisation on Four Welsh Farms*, Agricultural Economics Department, U.C.W., Aberystwyth, 1926, p. 10).

Applying these figures for labour requirements to the work units in Table II the measure of the task per person at each of the *Census* periods is represented by this index :

Index of the farming task as measured per person.

1871	100
1881	108
1891	118
1901	122
1911	116
1921	121

Had the organisation of 1871 been as efficient for work accomplishment as that of 1921 some 21 per cent. more work units could have been handled by the people then engaged.

This crude measure, however, does not take account of the tendency towards shorter hours of labour in the industry which has been in evidence, more or less, for the last forty years. Taking into account the differences in hours worked and in the tasks at the various periods, the approximate hours of labour required are shown in Table III.

Because of the differences in the task, both in the items and the total, the differences in the daily hours of labour, and those in the efficiency of the organisation or the ease and speed with which work has been accomplished, it is difficult to get an exact measure of the increase in efficiency from Table III. Another measure is obtained by comparing the total hours required for the existing task in each period as per Table III with the hours required for the same units and total task at the unit requirements as in 1921.

Task (work units) as in Year.	×	*by Unit requirements of 1921.*	*Total hours required as per task and unit requirements (Table III).*	*Difference per cent.*
1871		,, = 1987	2,747	38
1881		,, = 2141	2,728	27
1891		,, = 2335	2,690	16
1901		,, = 2410	2,622	9
1911		,, = 2290	2,529	10
1921		,, = 2409	2,409	0

Yet another measure of the increase in efficiency is obtained if the unit requirements at each period as in Table III are applied to the units of task 1921.

TABLE III.

Comparison of the farming task and of hours required.—Per person in Welsh Agriculture, 1871–1921.

Acres and numbers.	1871		1881		1891		1901		1911		1921	
	Units per person.	*Hours per unit.*	*Units per person.*	*Hours per unit.*	*Units per person.*	*Hours per unit.*	*Units per person.*	*Hours per unit.*	*Units per person.*	*Hours per unit.*	*Units per person.*	*Hours per unit.*
Arable (all crops) ...	6.7	146	6.47	132	5.90	118	5.51	113	4.86	114	5.61	103
Grass — pasture and hay ...	17.25	13	21.88	12	25.09	11	27.15	10	26.21	10	25.38	9
NUMBERS.												
Horses (all types) ...	1.09	140	1.39	130	1.59	119	1.79	114	1.80	116	1.94	105
Cattle (all types) ...	5.46	106	6.49	98	7.85	89	8.43	84	8.18	86	8.51	78
Sheep (all types) ...	25.11	4.5	25.26	4.5	33.69	4	39.16	3.75	39.66	3.75	36.93	3.5
Pigs (all ages and types) ...	2.03	70	2.04	66	2.57	61	2.50	58	2.43	60	2.29	54
Total hours allocated to specific crops and stock ...		2198		2183		2152		2098		2023		1927
Hours to general work establishment, etc.		549		545		538		524		506		482
Total hours per person		2747		2728		2690		2622		2529		2409
Hours per person per day* ...		9.12		9.06		8.93		8.71		8.40		8

* The hours per person per day are put in as a convenient form of comparison. The true comparison is that of hours per year. The number of effective working days was probably a little smaller in the earlier than in the later periods.

	Total hours.
Task (work units) of 1921, × by unit requirements ...	1921 = 2,409
,, ,, ,,	1911 = 2,655
,, ,, ,,	1901 = 2,618
,, ,, ,,	1891 = 2,771
,, ,, ,,	1881 = 3,058
,, ,, ,,	1871 = 3,312

Had the standard of work accomplished, or of efficiency, which existed in 1871 continued until 1921 some 37 per cent. more labour or of labour time than was used on the farms would have been required in that year.

Extra labour required for 1921 work.	*At standard (unit requirements).*
%	
37	Of 1871
26	,, 1881
15	,, 1891
8	,, 1901
11	,, 1911
0	,, 1921

This increase of 37-38 per cent. is in effect an increase in work accomplishment per hour of labour. Tracing the increase to its elements, the task has increased to 21 per cent., while the hours worked have been reduced by 12¼ per cent.

	Task.	*Hours.*
1871	100	100
1921	121	87¾

$$\frac{\text{Task}}{\text{Hours}} \quad \frac{121}{87\frac{3}{4}} = 100 : 137.7$$

Such measurements do not deal with the semi-moral or human questions as whether the present day workers (including working farmers and farmers' relatives) are willing to work as strenuously as those of previous generations, whether they are more or less interested in their work, or whether they are more or less skilful. They only deal with the economic conditions in the industry as they have arisen in connection with those conditions in the country at large. All parties in the industry have claims to shares of the results of improvements which may be made in its organisation. Economic progress which did not lighten the burden of manual work in an industry organised as was agriculture in the eighteen-sixties and seventies would be of little human value. The measurements above show that work is now accomplished with less manual labour-power than at any previous time for which records are available.

The only possible qualification of this statement would arise from a consideration of yields of crops and live-stock. But the yields of crops generally show increases from 1885 to 1914 or thereabouts. Allowing for yearly fluctuations in yields which are due to climatic conditions, the tendencies of changes have been as follows :—

Crop.	*Yield tendencies.*
OATS ...	Increase 1885 to 1910, highest yield 1906, decrease during and after war years.
BARLEY ...	Increase 1885 to 1910, highest yield 1902, decrease during and after the war.
WHEAT ...	Increase 1885 to 1919, highest yield 1918, decrease after 1918.
BEANS ...	Decrease 1885 to 1897, then increase to 1910, and fairly steady afterwards.
PEAS ...	Increase 1885 to 1915, then decrease.
POTATOES ...	Steady 1885 to 1899, decrease 1900 to 1909, then increase, and slight decrease after the war.
TURNIPS AND SWEDES ...	Increase 1885 to 1904, slight decrease 1905 to 1919, and sharper decrease after.
MANGOLDS ...	Increase 1885 to 1910, then slight decrease, and sharper decrease after war years.
HAY FROM CLOVER AND ROTATION GRASSES ...	Increase 1885 to 1915, then decrease.
HAY FROM PERMANENT PASTURES ...	Increase 1885 to 1910, slight decrease, and then sharper decrease after 1914.

As regards the *crops* it appears that in general a consideration of yields would tend to raise the " task " from the earliest *Census* dealt with to that of 1911, and that the measurement for 1921 is the only one likely to be adversely affected by changes in yields, and they were due to peculiar circumstances arising out of war conditions, particularly exhaustion of fertility.

As regards *livestock*, the numbers per 1,000 acres and per person have increased, as shown in Table I. Sales of cattle have recently been very heavy[3]. Sales of sheep are larger than formerly. While numbers of pigs as at June 4th each year show little change it is practically certain that the proportion of sales to any given number of breeding stock is larger than formerly. If quality, as well as numbers, of livestock is taken into consideration there can be no doubt that the " task " has increased a little more than the increase shown by mere numbers. In the case of the cattle, the proportion of dairy herd to the total herd has been increasing[4], and it should be noted that amongst cattle the cows have the largest labour requirement. While the hours of labour per head average of all cattle is about 78 per year, the requirement of cows only is about 200 per year.

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[3] See this *Journal*, Ashby and Lewis, p. 11.

The causes of the increase in efficiency in work accomplishment were many and varied. The primary causes were : (1) The competition of other industries for labour under what, in practice, were attractive conditions. (2) The offer to farmers of more effective implements and machinery of types in existence in the sixties and seventies of last century; and of new types, especially of harvesting machinery in a more recent period.

As other and competing farmers were willing and able to use the new machinery, and other industries competed for labour, Welsh farmers were forced to adopt the labour-saving appliances which were offered to them. Some, doubtless, were willing and anxious to adopt them, irrespective of any pressure. In other cases a great deal of pressure was necessary to force the adoption. (In some districts the cream separator is absent from butter-making farms, and whole-milk is churned even at the present time.)

The general conditions of supply of capital and equipment for Welsh farms would tend to retard the rapid adoption of new equipment.

An indication of the extended use of power other than manual power, and to some extent of implements and machinery, is afforded by the increase in horse-labour. When it is remembered that this increase has been accompanied by a decrease in the proportion of land under cultivation, which requires much the greatest application of horse-power per unit, it is very striking.

Working horses, 1871–1921.

	Per 1,000 acres of land.	*Per person engaged.*
1871	27	0.65
1881	26	0.74
1891	27	0.84
1901	32	1.06
1911	34	1.04
1921	32	1.00

(See Tables I and II).

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[4] *Ibid.*, p. 7 and Appendix B.

While no exact statement of comparative amounts of power of mechanical origin in use at different periods is obtainable there can be no doubt that this power has been increasing.

In the cultivation of land the introduction of improved ploughs, cultivators and harrows was gradual, but steady; and the improved implements were lighter in draft and on the whole more effective both as regards quantity and quality of work than the traditional implements of Wales. Horse-hoes have reduced the manual labour, especially on root-crops. Corn and manure drills have been used widely in recent years, are now almost universal, and have effected large savings in manual labour. Up to 1880 most of the grain was cut by manual labour, but the introductions first of the reaper, then of the self-binder, have revolutionised harvesting processes. Similarly, up to 1880, most of the hay was cut and harvested mainly with manual tools. With the coming of the mower the heaviest task was lifted from the manual workers. The horse-rake had been introduced previously, but subsequent improvements, and then the addition of tedders, swath-turners, and side-delivery rakes, further reduced the requirements of manual labour. At the stack or barn, the introduction of the pulley or the rotary elevator again removed heavy and time-absorbing tasks. More recent introductions, like the mechanical pitcher, are still reducing the manual work at hay harvest. At the homesteads and in the barn, improved chaffing, crushing, and pulping machines have diminished labour, even where the old water-wheel is in use; but the extended use of the small internal-combustion engine has substantially increased the effectiveness of manual labour. In the dairy again, the cream separator and improved churn have reduced labour requirements.

These are merely indications of some of the changes. But it is particularly necessary to notice that the harvesting machinery, and to some extent the improvement and extension of use of cultivating equipment, has made a vast reduction in the amount of *casual* labour required. If the amounts of casual labour in use at rush times of the year could be added to the amounts of regular labour as shown by the various *Censuses*, the increases in work accomplishment per person would be greater than those shown above. The amounts of casual labour used, especially at the periods 1871, 1881, 1891, were very much greater than those of the present time; and the amounts used are still being reduced.

As regards handling of livestock, there is no doubt that the amounts of manual labour devoted to them, in relation to the numbers and quality of product, have also been reduced. In addition to the changes noted in respect of barn and dairy equipment, the labour requirements per head would be reduced as numbers increased. Where stock are handled in small numbers, as on the small farms of Wales, an increase in numbers does not require a proportionate increase in labour-time. Apart from this consideration, however, livestock are now attended to with greater despatch and on the whole with greater efficiency than formerly.

On the whole, there can be no doubt that the work accomplishment per person is now very much greater than during the latter part of the nineteenth century; and if the increase in efficiency is put at 40-45 per cent. the estimate may err on the low side. But this increase is in the efficiency of the whole organisation, and is specially related to such changes in equipment and organisation as have been noted above.

There remain two special matters for consideration, namely, the slackening of the process of improvement round about 1911; and some local variations in efficiency and in progress.

The increase in numbers of persons engaged in agriculture between 1901 and 1911 was common to England and Wales[5]. It was probably most important in the years 1906—1911 when agriculturists were feeling the benefit of rising prices. At the same time there was a decline in the real wages of employment in other industries, and these were making less effective competition for labour hitherto engaged in agriculture. There is, in fact, some indication of a return of labour from other industries to agriculture at this period. With a more plentiful supply of labour for farming, or with less drain on the supply, farmers were using labour rather more liberally and less intensively than ten years earlier. A little increase in production was being made, but it was not equal to the increase in persons engaged in the industry. Had the improvement in economic conditions, especially the rise in prices, in agriculture continued it is possible that farmers might have intensified or extended production more rapidly and thus used more effectively the more plentiful supply of labour. But before this change could take place in any important degree, other changes were to occur, and the drain on labour supplies caused by the war conditions again forced farmers to economise in the use of manual labour.

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[5] But the numbers in 1901 were reduced by a special cause, namely the draft of men by recruitment for the South African War. It appears probable that Wales supplied about 2,000 agriculturists and that what would otherwise have been the number of men engaged was reduced by this number. This affects the actual figure shown, and possibly is about sufficient to remove the whole difference between the apparent standards of efficiency in 1901 and 1911.

In a similar study of efficiency of farm labour in England and Wales[6] *it was found that the efficiency, as measured by work accomplishment per person, tended to be higher in the neighbour*hood of an industrial county (Durham) than in more purely agricultural counties (Oxford and Dorset)[7]. It seemed desirable therefore to attempt to discover whether any such differences exist it Wales. But because of the change in the areas used for *Census* purposes—the change from the Registration to the Administrative Counties in 1901—it is only possible to obtain broad comparisons which can be shown with an adequate degree of reliability. The comparisons here given are for the six counties of North Wales and the seven counties of South Wales (including Monmouth).

The total area of North Wales is about 2,050,000 acres, and that of South Wales about 3,050,000 acres, while the respective populations are 540,000 and 2,116,000. The density of population and the " pull " of urban and industrial employment have been much greater in South than in North Wales.

Owing to the influences of various conditions, topographical, economic, and social, there are some differences in the general organisation of farming in North and South Wales. The number of persons engaged per 1,000 acres is greater in the North than the South, and the proportion of arable land also greater in North than South, while the average size of holdings is greater in South than in North Wales. While it is difficult to get an exact measure of the average size of farms it is probable that the average farm in South Wales is some 20-25 per cent. greater than the North, although some counties, like Carmarthen, have large numbers of small farms.

The figures indicating the land and stock managing capacity per person at the various periods are given for North and South Wales in Tables IV and V respectively. In general, the simple figures indicate that the power of work accomplishment, or the efficiency, of farming organisation is greater in the South than the North. This corresponds with expectations arising from previous studies[8], and it illustrates the effect of competition for

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[6] *Wages and Conditions of Employment in Agriculture*, *Cmd.* 24, 1919. " Efficiency of Labour ", pp. 61-75, especially pp. 71-75. (This study should be consulted for some more general considerations than have been possible in the present paper).

[7] On this point see also Lennard, *English Agricultural Wages*, Ch. III.

[8] See previous references.

TABLE IV.

Land and Stock Managing Capacity, North Wales, 1871-1921.

Acres of land and numbers of livestock per person engaged in Agriculture for six counties of North Wales.

Period	*Arable.*	*Grass.*	*Total cult. area.*	*Work horses.*	*Other horses.*	*Total horses.*	*Cows and heifers in milk and in calf.*	*Other cattle.*	*Total cattle.*	*Total sheep.*	*Total pigs.*
1871	6.46	14.73	21.19	.55	.39	.94	2.17	3.12	5.29	25.55	2.22
1881	5.95	18.82	24.77	.64	.54	1.18	2.39	3.75	6.14	27.57	2.20
1891	5.60	21.16	26.76	.72	.56	1.28	2.78	4.59	7.37	34.56	2.80
1901	5.07	23.13	28.20	.88	.54	1.42	2.86	4.97	7.83	39.35	2.52
1911	4.57	21.90	26.47	.85	.56	1.41	2.83	4.94	7.77	41.54	2.38
1921	5.03	22.13	27.16	.79	.73	1.52	3.20	5.15	8.35	39.38	2.18

TABLE V.

Land and Stock Managing Capacity, South Wales, 1871-1921.

Acres of land and numbers of livestock per person engaged in Agriculture for seven counties of South Wales.

Period	*Arable.*	*Grass.*	*Total cult. area.*	*Work horses.*	*Other horses.*	*Total horses.*	*Cows and heifers in milk and in calf.*	*Other cattle.*	*Total cattle.*	*Total sheep.*	*Total pigs.*
1871	7.00	19.14	26.14	.72	.47	1.19	2.36	3.22	5.58	24.79	1.88
1881	6.85	24.19	31.04	.82	.73	1.55	2.75	4.05	6.80	23.52	1.91
1891	6.15	28.15	34.30	.94	.90	1.84	3.30	4.93	8.23	33.03	2.40
1901	5.87	30.84	36.71	1.20	.88	2.08	3.46	5.44	8.90	39.01	2.49
1911	5.08	29.48	34.56	1.20	.91	2.11	3.35	5.17	8.52	38.17	2.47
1921	6.06	27.95	34.01	1.16	1.11	2.27	3.69	4.96	8.65	34.99	2.37

labour and the general influences on farming organisation exercised by other industries in the neighbourhood.

The farming of North Wales has not by any means been outside the sphere of influence of other industries. The coal mines on the east, the quarries on the west, and the residential areas of the north coast all have had their influences on North Wales farming. But the density of industrial settlement has been greater in the South than in the North, and on the whole the northern industries have been organised on a smaller scale than the southern. This refers, of course, to the past, and particularly to the period 1871-1921. Exactly what may be the influence of present industrial conditions in South Wales it is difficult to say, but it is improbable that they will lead to very much greater extension of the use of manual labour on the farms of the area. While it is true that potential labour supplies are more plentiful at the moment than for some decades, and apart from the operation of the Agricultural Wages (Regulation) Act, 1924, conditions of employment would not be rigidly insisted upon, it is also true that the farmers of the area are feeling very keenly the loss of a considerable part of the effective consumers' market in the neighbourhood. Some increase in the use, or at any rate the residence, of manual labour is to be expected on the smaller farms of South Wales, especially in certain districts from which much labour has hitherto migrated. Not only has the stream of migration been stopped to some extent, but a return flow has been apparent during the last year or two. But it is probable that the increase in manual labour will be more important on the relatively small farms situated at some distance from the industrial areas than on the larger farms more in contact with the large industries and which hitherto have been most subject to their influences. Such farms have been more completely organised to carry on with a minimum of manual labour, and it is unlikely at this stage that their equipment will remain unused while manual labour is employed, especially in view of restrictions imposed by the Agricultural Wages Act. On the smaller farms, on which members of the family are mainly engaged, the restrictions on employment are not so rigid, in practice, as elsewhere. There are, of course, no restrictions on mere residence and incidental working.

The comparative efficiency of the present farm organisations of North and South Wales is most simply indicated by a comparison of the units of land and stock managed and the approximate labour requirement per unit in 1921.

Had the North Wales units of work been accomplished with the hours as required per unit in South Wales about 10 per cent.

less labour would have been required than was used. Again, this does not indicate any human superiority in the people of South Wales, but only the result of differences in farm organisation.

Comparison of Farm Organisation, 1921.

	North Wales.		*South Wales.*	
	Units per person.	*Approximate hours labour per unit.*	*Units per person.*	*Approximate hours labour per unit.*
Arable acres ...	5.03	114	6.06	98
Pasture, etc., acres ...	22.13	10	27.95	8.6
Horses ...	1.52	114	2.27	100
Cattle ...	8.85	84	8.65	74
Sheep ...	39.38	3.4	34.99	3.5
Pigs ...	2.18	57	2.37	51.3
Total direct labour ... (hours)	1,927		1,925	
General and est. labour ...	482		482	
Total hours per person	2,409		2,407	

For 1871 the comparison is as follows :—

Comparison of Farm Organisation, 1871.

	North Wales.		*South Wales.*	
	Units per person.	*Approximate hours labour per unit.*	*Units per person.*	*Approximate hours labour per unit.*
Arable acres ...	6.46	153	7.00	141
Pasture, etc., acres ...	14.73	15	19.14	12
Horses ...	.94	162	1.19	128
Cattle ...	5.29	109	5.58	103
Sheep ...	25.55	4.5	24.79	4.5
Pigs ...	2.22	64	1.88	75
Hours of direct labour	2,197		2,195	
General and est. labour ...	549		549	
Total hours per person	2,746		2,744	

If the units of work in North Wales in 1871 had been done with the labour-time required per unit in South Wales some 8 per cent. less labour would have been required. Progress in farm organisation for the accomplishment of work has been a little greater in South Wales than in North Wales, but the greater industrial development of South Wales had considerable influence on farm organisation prior to 1871.

The amount of progress made in each area since 1871 is indicated by these figures. If the South Wales task of 1871 had been accomplished by the time required for each unit in 1921 the reduction in labour time would have been about 40 per cent., while if the North Wales task of 1871 had also been accomplished by the time required for each unit in 1921 the reduction would have been about 38 per cent., or, if the task in South Wales of 1921 had required the same amount of time per unit as in 1871 the total requirement of labour-time would then have been 40 per cent. greater; and if that of North Wales in 1921 had required the same amount of time per unit as in 1871, the increase would have been 38 per cent.

Were it possible to obtain reliable estimates of the cash value of gross and net output of Welsh farms at some of the dates mentioned in this investigation it would be far better to use such estimates in an attempt to measure the economic efficiency of the industry. But in this case the measure would not be of quite the same character as that used above, for the elements of capital, use of capital, and managerial ability are more important in determining the value of goods than in determining quantities such as used here, because of the quality basis of cash values. While it is desirable to obtain measures of the economic productivity of farm organisation, the information yielded by this investigation may assist in leading agriculturists to a better understanding of the recent—and probably yet forthcoming—changes in the labour organisation of the industry.

Summary.

The use of manual labour on farms is conditioned to a very large extent by the neighbourhood of other industries, their demand for labour, and the conditions of employment which they offer. Manual labour in farming is assisted, supplemented, sometimes substituted by implements or machines and by horse or mechanical power. As measured in assistance to each person engaged in the industry the increase in the use of equine power in Welsh agriculture 1871 to 1901 was 68 per cent., and 1871 to 1921 it was 54 per cent. There has also been an increase in use of mechanical power. Conditions of supply of capital and equipment retarded the adoption of new equipment, but there has been a greatly increased use of new or improved implements, or machines. Reductions in manual labour, number of persons per 1,000 acres of land have occurred, and hours of labour have been reduced. But the total amount of work accomplished per person, as measured by the quantities of land and stock managed, has increased. The increase in the efficiency of farm organisation for work accomplishment in the whole of Wales, 1871-1921 is estimated at 40-45 per cent., but a definite increase of 37 per cent. can be traced. The farm organisation of South Wales had already been considerably affected by the relative shortage of labour before 1871. At that date the relative efficiency in North and South Wales respectively was about as 100 to 108, yet progress in the South was a little more rapid after 1871, and the relative efficiency of North and South in 1921 was about as 100 to 114. Fairly definite increases in work accomplishment have been found for North and South Wales, the respective figures being 33 and 40 per cent. Taking into account the less certain factors, it is probable that the increase for North Wales lies between 35-38 per cent., and that for South Wales between 43-47 per cent. These figures do not necessarily indicate any change in human capacities or qualities ; they measure changes in economic organisation. The efficiency of farm organisation for work accomplishment is the result of the combination of manual labour, capital embodied in equipment, and the managerial element.

WASTAGE IN DAIRY HERDS— VARIATION ACCORDING TO SEASON OF CALVING.

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In dairy herds one of the chief causes of loss and disappointment is the number of cows which have to be removed at a comparatively early age. In Welsh Black cattle recorded by the Caernarvonshire and Anglesey Milk Recording Society it has been shown (1) that the maximum yielding capacity is not reached before the fifth lactation. In the case of cows recorded by the Norfolk Milk Recording Society the maximum occurs at the end of the sixth or seventh lactations (2). As the yield does not fall off very rapidly, even after the sixth or seventh lactation, it is obviously desirable that good cows should be utilised for breeding purposes until about their eighth or ninth lactation. In practice, however, many cows have to be got rid of before they have even reached their best age. Apart from the removal of heifers and cows which prove to be disappointing milkers, the main causes for such wastage are udder trouble, sterility, abortion and, in the case of herds producing Grade A (T.T.) or Certified milk, reaction to the tuberculin test. The investigation here described was undertaken in order to ascertain the extent of the wastage and to discover, if possible, factors which might throw some light on the reason why dairy farmers aiming at heavy milk production should experience so much greater loss than, for instance, farmers who are aiming at the production of store cattle combined with the sale of butter.

The herds from which the information was collected are kept for the production and sale of liquid milk all the year round. As far as possible the numbers of the herds are kept up by home bred heifers, and cows of a satisfactory standard are kept in the herds until, at least, the period of maximum production, unless for one of the causes mentioned above, udder trouble, etc., they have to be sold off.

In these herds, out of a total of 260 cows—

13 or 5.0%	left the herds	before calving their	2nd calf.
58 or 23.3%	do.	do.	3rd ,,
117 or 45.0%	do.	do.	4th ,,
163 or 62.7%	do.	do.	5th ,,
192 or 73.8%	do.	do.	6th ,,
220 or 84.5%	do.	do.	7th ,,

leaving 40 or 15.5% to calve their seventh calves in the herd. These figures do not include reactors to the tuberculin test, so that a still higher rate of wear and tear would be found in herds producing Grade A (T.T.) or Certified milk.

In order to keep a herd of 100 cows up to strength, twenty-six heifers would have to be drafted in each year if cows are weeded out at the above rate and if it be assumed that no cows are retained after calving their seventh calf. Should a younger herd be desired, the number of heifers drafted in would have to be increased accordingly. It is impossible to ascertain from the registers the reason for the elimination of most of the cows from the herd. If such were possible, light would be thrown on a serious problem, and an impetus would be given to its investigation. The losses from the herd become obvious in practice through the difficulty of keeping herds up to strength, even though all the heifer calves may be reared. With such a rate of wastage as that given in the above table, it is practically impossible to follow the oft-repeated advice of keeping only the heifer calves from the best cows—nearly all heifer calves have to be retained to make up for the heavy depreciation in the numbers of the herds. Thus, in many herds there will not be much opportunity of improvement by selective breeding as far as the females are concerned until the rate of elimination of cows from the herd is so reduced as to enable some heifer calves to be discarded. If the period of utility of the average cow could be lengthened it would affect not only the immediate cost of production of the milk but would facilitate the improvement of the herd through selective breeding.

The difficulty of replacing cows is particularly serious for producers of Grade A (T.T.) and Certified milk, especially in view of the danger of importing contagious abortion into the farm. It is obvious that with both the tuberculin and blood test to surmount, procuring a suitable animal becomes a matter of great expense in time and money. The purchase of heifers lessens these dangers, since they are much less likely to have been put on the market for failure to pass these tests. The difficulty of buying suitable animals is likely to increase through an inevitable increase in the practice of tuberculin testing which will occur through a growing demand for the best grades of milk. Thus, lengthening the period of profitable production of cows will have important results for such producers since it will make them less dependent, and in many cases altogether independent of purchased animals.

Variations in "Wastage" according to Seasons of Calving.

The herd records were examined in order to find whether the period of the year in which the cows calved their first calf rendered them more liable to the many causes which take them out of the herd. A difficulty arises in that there are a number of factors which are responsible for cows being eliminated from a herd, and that it is possible that the conditions favouring one factor might act in the opposite way with the other. It is not considered probable, however, that two of the chief factors—udder trouble and a very poor milking capacity—will be favoured by very different conditions. It was proved (3) that June, July, August calvers at the College Farm, Aber, gave a significantly lower yield than those calving in March, April and May. Thus, there would be a greater proportion of very low yielders among cows calving at such a period, and consequently more cows would be removed for this reason from a herd having a large proportion of cows calving about mid-summer. With regard to udder trouble, it is generally believed that the "dry period" occurring in summer renders a cow more liable to it. Thus, should this be correct, spring calvers would be less liable to loss from this source than those calving in June, July and August. However, owing to the absence of information from the registers, the incidence of period of calving is only considered with respect to the net result of all the various factors responsible for cows leaving the herd prematurely.

The milk records were examined to find whether "wear and tear" was affected by the season of the year in which the cows calved their first calf. Thus :—

Month of calving first calf.	
March, April, May ...	Out of 43 cows, 14 or 32.5% left herd before their 4th calf. and 23 or 53.5% left the herd before their 5th calf.
June, July, August ...	Out of 72 cows, 43 or 59.7% left herd before their 4th calf. and 52 or 72.2% left the herd before their 5th calf.
September, October, November	Out of 45 cows, 19 or 42.2% left herd before their 4th calf. and 26 or 57.7% left the herd before their 5th calf.
December, January, February	Out of 80 cows, 41 or 51.3% left herd before their 4th calf. and 55 or 68.7% left the herd before their 5th calf.

Thus, wastage appears to be less in the case of spring calvers and heaviest in the case of summer calvers. The number of observations is not sufficient for a detailed examination of the results. While the difference between spring and summer calvers, for instance, appears to be significant, the fact that September, October, and November calvers appear to have a lower loss through wastage may be due to chance.

To examine the question from another angle, the records of cows which were retained in the herds for two only, for four only, and for six successive lactations were examined to ascertain whether the cows which were retained for six successive lactations had a greater proportion of cows which had calved their first calf in spring than those cows with only two or four lactations.

Of 68 two-lactation cows	18% calved their first calf in	March,	April,	May.
Of 120 four-lactation cows	21%	do.	do.	do.
Of 48 six-lactation cows	25%	do.	do.	do.

Thus, in the case of the herds in question, spring calvers appear to have stayed in the herd longer than summer calvers, being more resistant to various factors responsible for their removal.

In determining (4) the distribution of month of calving for cows at different ages, it was shown that while only 17% of first-calvers calved in March, April, May, the proportion was considerably increased by the time the cows calved their sixth calves.

Table I gives the proportion of cows at different ages which calved in these months; the figures vary a little from the original owing to the inclusion in this table of only those cows of which particulars were available for every calving up to the age indicated.

TABLE I.

Of first calvers ...	17% calved in	March,	April,	May.
Of second calvers ...	30% do.	do.		do.
Of third calvers ...	35% do.	do.		do.
Of fourth calvers ...	33% do.	do.		do.
Of fifth calvers ...	42% do.	do.		do.
Of sixth calvers ...	42% do.	do.		do.

If cows which calve in spring are less liable to be removed from the herd than those calving at other times, it is obvious that the increase in the proportion of spring calvers with the age of the cows is not due entirely to increased tendency of cows to calve in these months as they get older. To determine how much of the increase in the proportion of spring calvers is due to an increased tendency of the average cow to calve in spring as she gets older and how much is due to spring calvers being more likely to remain to the later ages than cows calving at other times, the data were examined as follows. Particulars of all cows were noted in which the month of calving of the first and second calves were known, and the number of cows which calved their first calf in spring noted. Thus, of a total of 252 cows, forty-five calved their first in spring. The number of cows out of the 252 calving their second calf in spring was then noted (seventy-six in this case) and the difference between the two, viz., 76—45=31, gives the number of cows which, though not spring calvers originally, became spring calvers with their second calf. The proportions were found in a similar way for cows of the other ages. These are shown in Table II, together with the percentages.

TABLE II.

Description of cows.	*Number of cows.*	*Total number calving in spring at age indicated.*	*No. which calved first calf in spring.*	*No. which did not calve first calf in spring but which became spring calvers by the time they reached the age indicated.*
1st calvers	269	45 or 17.0%	45 or 17.0%	—
2nd calvers	252	76 or 30.1%	45 or 17.8%	76-45 = 31 or 12.3%
3rd calvers	188	66 or 35.1%	35 or 18.9%	66-35 = 31 or 16.2%
4th calvers	120	39 or 32.5%	25 or 20.8%	39-25 = 14 or 11.7%
5th calvers	79	33 or 41.8%	17 or 21.5%	33-17 = 16 or 20.3%
6th calvers	48	20 or 41.6%	12 or 25.0%	20-12 = 8 or 16.6%

In this table third calvers, for example, include all cows with the month of calving known for the first and third calves, and include some cows which may be retained for many more calves. This is because the observations are concerned with the time of calving of all cows reaching a particular stage, and not with the age at which they leave the herd. Column 4 gives the number and percentage of cows of the age indicated in the first column which calved their first calf in spring. It will be observed that this percentage gradually increases from second to sixth calvers.

Conclusions.

1. A heavy wastage occurred in the herds under review, and is of such magnitude as to require on an average the drafting of twenty-six heifers annually into a herd to keep it at a strength of 100 head, even when suitable cows are retained until their seventh calf.
2. Heavy wastage limits the extent to which a herd can be improved by selective breeding.
3. Summer calvers were more subject to wastage than spring calvers.
4. The increasing proportion of cows calving in spring with advance in age is partly due to an increased tendency of cows to calve at this period when they get older and partly to the fact that cows which calved their first calf in other periods of the year are more subject to the various causes responsible for cows being weeded from the herd.

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WYN MYNYDD AR GYFER PESGI.

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Ers rhai blynyddoedd bellach y mae pesgi wyn stôr Cymreig o'r mynydd ar ffermydd yr iseldir yn ystod yr hydref a'r gaeaf wedi cymryd lle'r arferiad o besgi llydnod, neu fyllt. Clywir yn aml mai un o ragoriaethau arbennig defaid Cymreig yw y gellir darparu'r wyn gogyfer a'r farchnad gig ar bob tymor o'r flwyddyn. Hynny yw, daw wyn Cymreig " llawr gwlad " i'r cigydd o Ebrill i Fedi, ac yna daw'r wyn stôr o'r mynydd i'w

pesgi ar yr iseldir fel ag i fod yn barod i'r cigydd o Hydref i Fawrth.

Mae'r farchnad gig yn awr yn galw am anifail ieuengach o bob math—gwartheg, defaid a moch—ac felly gelwir ar i'r amaethwr gyfnewid ei ddull o fridio a bwydo ei anifeiliaid. Yr oedd ffrwyth profiad cenedlaethau wedi galluogi amaethwyr y gorffennol i fridio a bwydo myllt ar gyfer angen y farchnad. Ond y mae'r farchnad wedi newid a dylid ystyried a yw y bridio a'r bwydo heddyw yn cyfarfod anghenion marchnad ein dyddiau ni.

Mae'n wybyddus, er engraifft, mai haws yw pesgi eidion dwy i dair oed yn y gaeaf na phesgi eidion stôr blwydd i ddwy flwydd. Os am lwyddiant gyda pharatoi cig eidion ieuanc (*baby beef*) ar gyfer y farchnad rhaid bwydo'n dda o'r dechreu i'r diwedd yn ddi-fwlch. Yn yr un modd, y mae pesgi oen stôr yn wahanol i besgi llwdn o ddwy i bedair oed. Hefyd, os yw'r gymhariaeth a'r gwartheg i ddal gyda'r defaid y mae yn ofynnol rhoddi gwell magwraeth i'r wyn mynydd er mwyn osgoi'r cyflwr stôr yn gyfangwbl.

Teimlir, felly, fod gwir angen am ymchwiliad ynglyn a'r pwyntiau canlynol :—

1. Addasrwydd defaid mynydd Cymreig i ddarparu cig oen yn hytrach na chig llwdn ar gyfer y farchnad;
2. Prisiau a chyflenwad cig oen ar wahanol adegau o'r flwyddyn;
3. Cynnydd corfforol yr wyn ar wahanol adegau o ran tyfiant ac oedran.

Ynglyn a'r pen cyntaf mae profiad amaethwyr yr iseldir ac hefyd arbrofion y gorffennol[1] yn cadarnhau fod wyn Cymreig yr iseldir yn hollol addas i'r cigydd yn ystod misoedd yr haf, ac hefyd fod eu cig yn eithriadol flasus ac o faintioli priodol i ateb dibenion teuluol a galwad yr oes hon am ddarnau bychain o gig. Mae profiad a medr amaethwyr wedi sicrhau'r farchnad iddynt yn y cyfeiriad yma, ac y mae hyn i'w briodoli i raddau helaeth i'r ffaith eu bod wedi rhoddi'r sylw dyladwy i'r cwestiwn o fridio'n briodol ac hefyd i wella'r tir pori.

Mae yn amheus, er hynny, a yw'r wyn stôr o'r mynydd ddiwedd haf mor addas ag y tybir eu bod i'w pesgi yn ystod yr hydref a'r gaeaf. Cyfyd y cwestiwn ar unwaith a oes lle i ddisgwyl i oen besgi o dan anfanteision corfforol ac anfanteision y tymor. Ar wahan i hyn, dylid rhoddi sylw i fridio'r math goreu o oen tuag at besgi, a thrin y deadelloedd yn y modd goreu er sicrhau'r cyfryw i'r farchnad.

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[1] Phillips, R. " Rate of Growth in Lambs ". *Welsh Journal of Agriculture*, Vol. IV.

Pris y farchnad.

O ddilyn prisiau'r farchnad gig yn ystod y flwyddyn gwelir ar unwaith fod yna wahaniaeth o dymor i dymor ac o fis i fis. Ceir y pris uchaf am gig moethus oen y Pasg o dri i bedwar mis oed, yna mae'r pris yn araf ostwng ym Mai a Mehefin. Daw i gymdogaeth chwe' cheiniog y pwys byw o Orffennaf ymlaen i Fedi, a cheidw tua'r pris yma hyd y Nadolig bron. Ceir codiad araf o Ionawr ymlaen i fis Mawrth. Saif cig oen felly yn uchel ei bris yn ystod tymhorau prin eu twf, sef y gaeaf a'r gwanwyn, ac yn isel yn nhymhorau cyflawnder. Mae hyn yn cyd-redeg yn hollol a'r cyflenwad o wyn tewion—prinder wyn Pasg, digonedd o wyn Awst hyd Hydref a Thachwedd, a phrinder eilwaith o Ionawr ymlaen.

Mae prisiau a chyflenwad marchnad wyn stôr yn llai rheolaidd. Daw'r oll o dan y morthwyl yn ystod rhyw ddeng wythnos o ddiwedd Gorffennaf i ddechreu Hydref. Weithiau mae'r stôr cynnar yn uwch eu pris na'r rhai diweddarach, bryd arall yn hollol groes i hyn. Dibynna'r pris i raddau helaeth ar y galwad yn hytrach nag ar bwysau'r wyn. Y mae tuedd ers blynyddoedd bellach i wyn stôr fod ychydig yn uwch eu pris nag wyn tewion yr un adeg.

Cynnydd corfforol wyn.

Dangoswyd eisioes mewn lle arall y cynnydd corfforol a wna oen Cymreig ar dir da yn ystod yr haf.[1] Amcan yr erthygl yma yw dangos cynnydd corfforol oen stôr wrth besgi yn ystod misoedd yr hydref a'r gaeaf, ac hefyd ystyried (i) y math goreu o wyn i besgi—wyn Cymreig pur ynteu croesiad? wyn stôr goreu neu'r " cwlin "? (ii) y ddarpariaeth mewn bwydo gogyfer a'u pesgi, ac (iii) yr adeg oreu i'w gwerthu i'r cigydd gan gofio'r cynnydd, pris y farchnad, cost y cadw, a'r colledion trwy effeithiau clefydau megis y dwr coch, y bendro a'r pwd. Weithiau mae'r colledion yn cymryd toll drom, bryd arall ni chollir un mewn lot fawr. Daeth Howell[2] i'r casgliad fod y golled ar gyfartaledd yn bump y cant, ac fod y dwr coch bron yn waeth na'r un clefyd arall. Erbyn heddyw mae gennym foddion i atal ac i wella'r clefydau hyn, a thrwy gymryd y gofal priodol dylid osgoi'r colledion bron yn gyfangwbl.

Ynglyn a'r adeg gwerthu a'r gost, ceir ystyriaeth arnynt wrth ymdrin a'r cynnydd corfforol a wna'r wyn stôr wrth besgi, ac i'r pwrpas yma ceisir manylu ar y ffigurau a'r arbrofion canlynol :—

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[2] J. P. Howell. " The Productivity of Hill Farming ", 1922, ynghyda ffigurau eto heb eu cyhoeddi.

1. *Arddanghosfa Smithfield.*

Yng nghystadleuaethau Smithfield ceir dosbarthiadau gogyfer ag wyn Cymreig. O ddilyn pwysau'r wyn yn yr Arddanghosfa yma, gwelir yn ol y ffigurau canlynol am 1927 fod cryn wahaniaeth rhwng y gwahanol lotiau.

Yr oedd y lot drymaf yn pwyso ar gyfartaledd 95 pwys yr un tra nad oedd y lot ysgafnaf ond 78 pwys. Yr oedd y deunaw oen oedd yn y chwe' lot yn pwyso 85 pwys ar gyfartaledd.

A chaniatau nad yw'n hawdd cyrraedd safon Smithfield wrth besgi wyn stôr, eto dylid ymdrechu cyrraedd oddeutu 70 pwys yn fyw. Mae bron yn amhosibl ysywaeth cyrraedd hyd yn oed hyn hefo'r wyn a roddir ar y farchnad y blynyddoedd hyn.

2. *Arbrofion Coleg Aberystwyth,* 1910-12.[3]

Yn ystod y ddau dymor uchod defnyddiwyd wyn yn cael eu porthi ar wair er canfod gwahaniaeth gwerth gwair a dorrid ar wahanol fisoedd o'r flwyddyn—Mehefin, Gorffennaf, ac Awst. Trefnwyd yr arbrofion hyn, nid er mwyn pesgi'r wyn yn y modd goreu ond i bwrpas hollol wahanol. Yr oedd yr wyn yn cael eu bwydo o dan do, heb gael un cyfle i fynd allan i borfa am o ddau i dri mis. Er nas gellir cymryd yr arbrofion hyn yn brawf o'r cynnydd a ellid ddisgwyl mewn wyn, eto maent o gryn ddiddordeb ynglyn a'r mater dan sylw.

Yn y tabl isod gwelir nad yr un math o wyn, nac ychwaith yr un bwyd a ddefnyddiwyd yn y ddau dymor. Yn 1910-11, wyn pedigri Cymreig o ddeadell y Coleg a ddefnyddiwyd. Yr oedd y rhai hyn o bwysau da i gychwyn, ac mae'r tair lot yn dangos cynnydd. Danghosir yn y ddau dymor fod yr wyn gwrryw yn rhagori ar y benyw. Mae yma gynnydd hyd yn oed yn y misoedd sydd fel arferol mor anhawdd pesgi ynddynt, ac mae hyn yn awgrymu fod lles mewn cysgod ac hefyd fod wyn o'r math priodol yn gwella o dan amgylchiadau hollol annaturiol.

3. *Arbrofion Coleg Aberystwyth,* 1926-28.

Yn ystod y tair blynedd yma gwnaed ymchwiliadau ynglyn a chynnydd wyn stôr trwy gario allan arbrofion gyda gwahanol fathau o wyn a thrwy besgi o dan wahanol amgylchiadau.

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[3] C. Bryner Jones. "The Feeding Value of Meadow Hay cut at different dates". *Welsh Journal of Agriculture,* Vol. IV.

TABL I.—Arbrofion 1910–1912. Cynnydd wyn stôr a borthid ar wair a dorwyd ar wahanol adegau.

Blwyddyn.	*Brid.*	*Lot*	*Nifer*	*Bwyd wythnosol yr un.*	*Pwysau ar gyfartaledd.*						*Cynnydd.*	*Cynnydd Dyddiol.*
					Rhag. 30	*Ion. 13*	*Ion. 27*	*Chw. 10*	*Chw. 24*	*Maw. 10*		
1910-11	Cymreig o ddeadell y Coleg	1	10	8 pwys o wair Mehefin { 3½ pwys ceirch 14 pwys sweds	64.6	65.2	67.0	67.5	68.8	69.6	+ 5.0	owns. 1.1
1910-11	Cymreig o ddeadell y Coleg	2	10	8 pwys o wair Gorffennaf { 3½ pwys ceirch 14 pwys sweds	64.7	66.0	68.3	70.0	71.2	71.7	+ 7.0	1.6
1910-11	Cymreig o ddeadell y Coleg	3	10	8 pwys o wair Awst { 3½ pwys ceirch 14 pwys sweds	64.6	65.3	67.1	67.2	67.6	67.5	+ 2.9	.66
					Ion. 12	*Ion. 26*	*Chw. 9*	*Chw. 23*	*Maw. 8*	*Maw. 22*		
1911-12	Croes Kerry Hill—Cymreig o'r ardal	1	10	12 pwys o wair Mehefin	53.2	53.0	54.0	54.7	55.2	55.9	+ 2.7	.6
1911-12	Croes Kerry Hill—Cymreig o'r ardal	2	10	12 pwys o wair Gorffennaf	53.2	53.6	54.1	55.7	54.6	55.6	+ 2.4	.54
1911-12	Croes Kerry Hill—Cymreig o'r ardal	3	10	12 pwys o wair Awst	53.3	53.9	54.6	54.0	53.2	53.2	— 0.1	—

Arbrawf 1910–1911. Cymhariaeth cynnydd mewn wyn gwrryw a benyw.

Lot.	*Nifer.*	*Pwysau ar gyfartaledd.*						*Cynnydd.*	*Cynnydd Dyddiol.*
		Rhag. 30	*Ion. 13*	*Ion. 27*	*Chwef. 10*	*Chwef. 24*	*Maw. 10*		
1	5 gwrryw 5 benyw	64.8 64.4	67.2 63.2	69.6 64.4	69.4 65.6	70.6 66.8	71.8 67.4	+ 7.0 + 3.0	owns. 1.6 .7
2	4 gwrryw 6 menyw	68.0 62.5	70.0 63.3	73.5 64.8	74.7 66.8	76.7 67.5	78.0 67.5	+ 10.0 + 5.0	2.8 1.1
3	5 gwrryw 5 benyw	66.0 63.2	67.2 63.0	69.6 64.2	69.2 65.2	69.5 66.2	69.5 65.6	+ 3.5 + 2.4	.8 .55

Yn 1926 prynwyd nifer o wyn oeddynt croes Kerry-Cymreig yn Awst a threfnwyd i'w pesgi ar adladd clofer. Dengys y Tabl II y pwysau fel eu cofnodwyd ar wahanol adegau :—

TABL II.

Arbrawf 1926.

Cynnydd deunaw o wyn croes Kerry—Cymreig ar adladd clofer.

Dyddiad.	*Cyfanswm y pwysau.*	*Cyfartaledd.*	*Cynnydd dyddiol.*
		pwys.	owns.
Awst 10.	954	53.0	—
Medi 15.	1206	70.0	6.2
Hyd. 29.	1332	74.0	2.5

Canfyddir yn ol y ffigurau uchod fod cynnydd wyn stôr yn arafach o'u cymharu ag wyn bach a dan y famog yn gynnar yn y gwanwyn a'r haf.[4] Er hynny mae cynnydd yr wythnosau cyntaf gymaint ddwywaith a'r hyn yw yn ddilynol i hyn. Danghosir un-pwys-ar-hugain o gynnydd mewn un-wythnos-ar-ddeg. Rhaid cyfaddef nad oedd yr wyn yn wir dew ar y diwedd.

Ar ol hyn o brofiad gydag wyn stôr, ceisiwyd yn 1927 fesur y cynnydd mewn wyn a fagwyd ar fferm y Coleg, Nantcellan, yn 1927. Cadwyd pedwar oen gwrryw Cymreig, ac ar ol torri arnynt ddechreu Mai, buont gyda'u mamau ymysg y defaid drwy'r haf i'r hydref. Gosodir allan bwysau'r rhai hyn o'u bwriad hyd yr hydref yn Nhabl III.

Gwelir fod cynnydd cyflym gyda'r rhai hyn, ac yr oeddynt yn barod i'r cigydd bron drwy yr haf, ac yn fwy o werth ym Mehefin hwyrach nag un adeg arall. Mae'r cynnydd yn arafu fel y mae'r oen yn heneiddio, ac yn wir yn ystod y cyfnod Medi 20—Hydref 20, mae'r pedwar wedi ysgafnhau er yn pori ar adladd dol dda ond heb fwyd sych. Dengys y ffigurau'r posibilrwydd o allu magu wyn Cymreig i bwysau da erbyn yr hydref, ac hefyd y perigl o gadw wyn gwir dew ymlaen yn rhy hir nes iddynt ddechreu gwaethygu. Y mae hyn yn ddiameu yr un mor bwysig wrth ymdrin ag wyn hyrddod sydd yn rhidio neu yn ymlid.

Er mwyn cael gwybodaeth helaethach, trefnwyd yn 1928 i ddau wr profiadol i gadw pwysau nifer o wyn oedd yn pori ar y mynydd yn ystod yr haf. Prynwyd nifer o'r rhain, a cheisiwyd dilyn y cynnydd ar ol iddynt ddod i lawr o'r mynydd. Gwelir y ffigurau perthynol iddynt yn Nhabl IV.

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[4] Phillips, R. " Lambs as Meat Producers ". *Journal of the Agricultural Department, U.C.W., Aberystwyth,* 1928.

TABL III.

Arbrawf 1927. Cynnydd pedwar oen gwrryw pedigri Cymreig.

1 *Ganed.*	2 *Pwysau geni.*	3 *Ebrill 7.*	4 *Cynnydd dyddiol.*	5 *Mai 13.*	6 *Cynnydd dyddiol.*	7 *Meh. 9.*	8 *Cynnydd dyddiol.*	9 *Gorff. 2.*	10 *Cynnydd dyddiol.*	11 *Awst 16.*	12 *Cynnydd dyddiol.*	13 *Medi 20.*	14 *Cynnydd dyddiol.*	15 *Hyd. 20.*	16 *Colled dyddiol.*
	pwys.	pwys.	owns.	pwys.	owns.	pwys.	owns.	pwys.	owns.	pwys.	owns.	pwys.	owns.	pwys.	owns.
Mawrth 3, 1927	10	30	9.1	53	10.2	69	9.5	81	8.3	92	3.9	97	2.3	85	— 6.4
Mawrth 3, 1927	9	26	7.8	46	9.0	62	9.5	70	5.6	80	3.6	89	4.1	...	...
Mawrth 3, 1927	8.5	37	13.0	56	8.4	71	9.0	82	7.6	88	2.1	95	3.2	84	— 5.8
Mawrth 6, 1927	7.5	23	7.8	48	11.0	62	5.3	71	6.2	80	3.2	86	2.7	76	— 5.3
Cyfartaledd	8.75	29.0	9.4	50.75	9.6	66.0	8.3	76.0	6.9	85.0	3.2	91.75	3.1	81.6	— 5.8

TABL IV.

Arbrawf 1928. Cynnydd wyn ar y mynydd.

Lot.	*Ganed.*	*Nifer.*	*Pwysau geni.*	*Pwysau. Mai 25.*	*Cynnydd dyddiol.*	*Gorff. 6.*	*Cynnydd dyddiol.*	*Awst 3.*	*Cynnydd dyddiol.*	*Awst. 17*	*Cynnydd dyddiol.*
A	Ebrill 5—12	6 Gwrryw 6 Benyw	pwys. 6.1 6.4	pwys. 20.9 22.4	owns. 5.2 5.7	pwys. 31.7 32.8	owns. 4.1 3.9	pwys. 34.3 37.5	owns. 1.5 2.7	pwys. 37.0 39.0	owns. 3.1 1.7
		Cyfartaledd	6.25	21.65	5.45	32.25	4.0	35.9	2.1	38.0	2.4
B	Mawrth 20—28	6 Gwrryw 6 Benyw	pwys. 6.5 6.4	*Mai 5.* pwys. 17.0 18.5	owns. 4.0 4.6						
		Cyfartaledd	6.45	17.7	4.3						

Cynnydd wyn ar yr iseldir.

Lot.	*Ganed.*	*Nifer.*	*Awst 21.*	*Medi 24.*	*Cynnydd dyddiol.*	*Hyd. 30.*	*Cynnydd dyddiol.*	*Rhag. 7.*	*Cynnydd dyddiol.*	*Rhag. 21.*	*Colled dyddiol.*
A	Ebrill 5—12	6 Gwrryw 6 Benyw	pwys. 35.6 38.2	pwys. 44.7 48.8	owns. 4.8 5.0	pwys. 54.4 58.3	owns. 4.3 4.2	pwys. 58.1 61.9	owns. 1.6 1.6	pwys. 57.7 61.2	owns. — .5 — .8
		Cyfartaledd	36.9	46.75	4.65	56.35	4.25	60.0	1.6	59.1	— .65
B	Mawrth 20—28	6 Gwrryw 6 Benyw		43.3 41.3		54.5 49.0	5.0 3.4	59.0 52.4	1.9 1.5	57.1 52.0	— 2.17 — 1.31
		Cyfartaledd		42.3		51.75	4.2	55.9	1.7	54.5	— 1.81

Canfyddir fod tyfiant wyn mynydd ychydig dros chwarter pwys y dydd yn ystod Ebrill a Mai, sef cynnydd hanner mor gyflym ag eiddo'r wyn Cymreig a fegir ar fferm y Coleg. Nid ydynt yn dal i gynyddu hyd yn oed yn ol y radd yma, oherwydd yn ystod Gorffennaf ac Awst arafa'r tyfiant i ryw un neu ddwy owns y dydd.

Pwysa wyn mynydd ar eu bwriad 6½ pwys ar gyfartaledd a phwysant oddeutu 35-49 pwys yn Awst pan eu gwerthir i'r iseldir at eu pesgi. Mae'r pris a geir am danynt ar y farchnad yr adeg honno'n amrywio cryn lawer, ond yn gyffredin ceir bron fwy y pwys am danynt nag am wyn tewion.

Bu'r wyn hyn yn pori o flaen anifeiliaid ereill ar adladd clofer a gweirglodd, ac hefyd ar hadau yn cynnwys darn o glofer coch yr Eidal (*crimson clover*). Yn ystod mis Tachwedd dechreuwyd eu porthi a swêds, ceirch a blawd, a daethant i fwyta'n weddol hwylus.

Gwelir ffigurau ychwanegol yn y tabl ynglyn a'u tyfiant wrth besgi. Fel y rhai o'r blaen mae'r cynnydd yn rhyw chwarter pwys y dydd o Awst hyd Hydref, ond yn Nhachwedd arafant i ryw owns-a-hanner y dydd, tra ym mis Rhagfyr, er y porthiant a gant, gwaethygant bob dydd, ac yn enwedig ar dywydd gwlyb. Llwyddwyd i gael nifer i'r cigydd cyn y Nadolig ac yr oedd y rhai hynny wedi cynyddu yn agos i ugain pwys mewn tri mis. Ar yn un pryd gellir dweud mai'r unig reswm a roddir yn aml i ffermwr dros brynu wyn stôr yw fod rhywfaint gwell gobaith cael ychydig elw oddiwrthynt nag oddiwrth fustych stôr a gedwir dros y gaeaf.

Dengys y ffigurau yn y tabl uchod fod yna ychydig wahaniaeth yn nhyfiant y ddwy lot ac mae hyn yn cyd-fynd a'r dull o fridio. Yr oedd yr wyn yn lot A wedi eu cael oddiwrth hwrdd pedigri Cymreig a'r wyn yn lot B oddiwrth hwrdd arferol y mynydd. Tyfodd a phesgodd lot A yn gyflymach ac yr oeddynt yn barod i'r cigydd o flaen lot B. Awgrymir yma felly fod yna lawer o le i wella ynglyn a bridio'r wyn a ddygir i'r farchnad trwy ddewis hyrddod pwrpasol. Heblaw hyn, mae unigolion y ddwy lot yn gwahaniaethu llawer oddiwrth eu gilydd. Er engraifft, yn lot A enilla un 28 pwys ac un arall 19 pwys, ac yn lot B gwna un gynnydd o 19 pwys ac un arall ddim ond 8 pwys. Mae hyn yn dangos fod eto le i wella yn netholiad y mamogiaid a gedwir, ac nad yw'r salaf o'r wyn stôr, neu'r " cwlin ", yn werth trafferthu yn eu cylch.

Mae'r ffaith fod wyn allan ar y cae yn gwaethygu yn Rhagfyr yn awgrymu fod angen cysgod arnynt, ac mae arbrofion 1910-11 o dan do yn ymddangos fel pe'n cadarnhau hyn. Pan ddaw'r hin yn dynerach, a'r dydd yn hwy yn Chwefror a Mawrth, ceir fod wyn fel rheol yn cynyddu mewn pwysau yn lled rwydd ac fod yn yr adeg yma brinder ohonynt ac felly bris da i'w gael am danynt.

Ymddengys oddiwrth y ffigurau uchod fod cynnydd o ugain pwys mewn tri mis o amser yn gymaint ag a ellir ddisgwyl i wyn stôr arferol o'r mynydd i'w wneud. Mae'r elw yn yr oen, er hynny, yn beth gwahanol i werth yr ugain pwys hynny, oherwydd cyfnewidiadau ym mhris y farchnad. Ym misoedd Hydref a Rhagfyr mae pris yr oen yn ol y pwys yn llai na phan y prynwyd ef, a phan fyddo y pris yn ol y pwys yr un faint wrth brynu ac wrth werthu, mae'r oen yn werth deg swllt yn rhagor. Ar y llaw arall, ar ol y Nadolig daw yr oen yn werth mwy yn ol y pwys byw, ac mae gwerth y cynnydd yn cyrraedd deuddeg neu bymtheg swllt yr un, ar ol rhyw bedwar i chwe' mis o gadw a bwyd da. Mewn geiriau ereill ceir yn agos i dri swllt y mis, neu geiniog y dydd yr un, am gadw'r wyn hyn. A chymryd i ystyriaeth y gost a'r gofal, heblaw'r perigl o golledion, ymddengys ar un olwg nad oes obaith cael llawer o dâl am y drafferth. Ar y llaw arall, gellir defnyddio wyn fel moddion i roddi cnydau fel *rape* ar y farchnad mewn dull haws i'w gwerthu. Ceir fod y casgliadau uchod yn cyd-fynd a phrofiad nifer o amaethwyr sydd wedi talu sylw arbennig i'r mater yn ystod y blynyddoedd diweddaf. Bu adeg pan yr enillid punt neu ragor y pen mewn wyn fel hyn, ond yn y blynyddoedd diweddaf bu adegau y ceid colled ynddynt, ac o ganlyniad gwnaed i ffwrdd gan lawer a'r dull hwn o weithredu.

Buwyd mor ffodus a chael ffigurau gan rai amaethwyr a arferent bwyso'r wyn yn achlysurol, a gosodir y rhain i lawr yn y tabl a ganlyn :—

Amaethwr.	*Dyddiad y prynu.*	*Nifer.*	*Pwysau ar gyfartaledd.*	*Dyddiad y gwerthu.*	*Pwysau.*	*Cynnydd mewn pwysi.*
X	Awst 25	100	35	Chwef. 16	52	17
Y	Awst 17	60	40	Ion. 21	58½	18½
Z	Gorff. 17	12	42	Ion. 7	71	29

Mae cryn wahaniaeth rhwng y ddwy lot gyntaf a'r drydedd ac mae'r esboniad am hynny'n ddiddorol. Ynglyn a'r ddwy lot gyntaf wyn wedi eu magu ar y mynydd oeddynt ac yn cael eu gwerthu yn Awst. Bu'r rhai hyn yn pori adladd, *rape* a swêds ac hefyd yn cael gwair a cheirch adeg prinder. Addefir fod ugain pwys o enill ar gyfartaledd yn dda mewn wyn o'r fath yma, ond nad oedd y drafferth a'r cost yn cael eu clirio. Oherwydd hyn, y mae'r amaethwr yma wedi rhoddi'r arferiad i fyny. Am y drydedd lot, nid yw'r amaethwr yma ychwaith yn awr yn prynu wyn stôr o'r mynydd gogyfer a'u pesgi, am yr un rhesymau a'r uchod, ond gweithiodd allan ddull mwy pwrpasol iddo ei hun, a chanddo bellach well math ar oen i'w besgi, a dangosa'r pwysau y rhagoriaeth ar yr wyn stôr cyffredin. Cedwir mwy o famogiaid ar y fferm yma yn ystod y gaeaf nag a wnaed cynt a defnyddir hwrdd pedigri Cymreig atynt. Anfonir yn agos i'r drydedd ran o'r mamogiaid a'r wyn i'r mynydd yn ystod yr haf, a thelir tri swllt y cwpl am danynt yno, am na pherthyn i'r fferm luest mynydd. Ymdrechir i glirio wyn tewion y fferm yn gynnaryn yr haf. Yna daw'r wyn mynydd i lawr adeg cneifio ym mis Gorffennaf a darperir *rape* gogyfer a'u pesgi erbyn Ionawr. Felly, osgoir prynu stôr pan yn ddrud, bridir a megir wyn stôr llawer mwy pwrpasol i besgi heb fawr gost, oherwydd tal y gwlan am gadw ar y mynydd yn yr haf, ac yn ol profiad y tair blynedd diweddaf mae'r wyn mynydd yn dod o gymaint gwerth yn y gaeaf a'r wyn tewion yn yr haf.

Mae yn ddiameu fod rhagor o le i ddatblygu'r dull yma o ymwneud a phesgi wyn y gaeaf, yn enwedig ar leoedd sydd a chanddynt luest mynydd, neu lle mae'n bosibl anfon y defaid a'r wyn i'r mynydd yr haf fel yn yr achos uchod. Wrth gwrs, y mae colledion gyda'r dull yma o drefnu hefyd, oblegid weithiau ni ddaw yr oll a aeth i fyny yn y gwanwyn yn ol yn yr hydref. Y ddau reswm pennaf dros gefnogi'r dull yma yw'r ffaith na wneir ymgais briodol ar y mynydd eto i ddethol y mamogiaid a dewis hyrddod pwrpasol gogyfer a rhoddi wyn stôr da ar y farchnad, ac nad yw cyflwr yr oen stôr yn ddigon da pan ddaw o'r mynydd iddo allu pesgi yn y gaeaf. Bydd tuedd wrth ddatblygu'r dull yma i ddod a phris yr wyn stôr mynydd yn is y pwys na phris wyn tewion yr un adeg, ac hefyd i gael gwelliant yn y math o wyn stôr i'r farchnad.

Bydd lle felly i'r ddau gynllun, sef,

1. Bridio a phesgi wyn stôr,
2. Prynu a phesgi wyn stôr,

gydweithio er darparu cig ar gyfer misoedd y gaeaf.

THE WARMBOLD SYSTEM UNDER WELSH CONDITIONS.

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AND

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" In all cases, where fatting cattle or dairy cows make a part of the stock, and where situation, soil, and water will permit, every suite of grazing ground ought, in my idea, to consist of THREE COMPARTMENTS. One for head stock (as cows or fatting cattle), one for followers (as rearing or other lean stock), and the third to be shut up to freshen for the leading stock.

If, at the time of shifting the followers there be *much seedy herbage* left upon the ground, it ought to remain until they be shifted; and to be MOWN AS HAY during the recess.

But if, at that time, *a few weeds*, and a *little seedy herbage* only be left, they ought to be SWEPT down, with the sithe, a few days before the removal of the lean stock; which will not fail, in this case, to lick up even the sharpest thistles, while they are in the soft flaccid state, to which mowing presently reduces them. . . . . not a weed ought to *seed*, nor a tuft of *stale grass* be suffered to stand, in a pasture ground; which ought once, at least, during the summer, to be LEVELLED WITH THE SITHE; thus, at a small expense, converting WEEDS INTO NUTRIMENT, and WASTE GROUND INTO AFTERGRASS ".

Thus wrote Marshall (1) in 1788. In fact most of the recommendations made to-day in connection with the so-called New System of Grassland Management are discussed at considerable length in the published works of Marshall and other writers of the latter part of the eighteenth and the first half of the nineteenth centuries. These writers advocated rotational grazing, close grazing, mowing, harrowing, separation of stock into " leaders " and " followers " and grazing with mixed stock, with a view to improving the method of grassland husbandry.

During the past few years a special effort has been made by agricultural scientists to ascertain the extent to which a method of grassland management, based largely on the recommendations indicated above, may be adopted with a view to raising the general level of production under present economic conditions.

There are, however, two distinctive features of the present day investigations which could not have been associated with those conducted over a hundred years ago.

In the first place, the introduction of artificial manures has provided additional facilities for increasing soil fertility. The use of phosphatic fertilisers and potash manures, where needed, on grassland became a widespread practice during the latter half of last century. It was only in recent years, however, as a result, more particularly, of German investigations conducted during the war, that the possibility of increasing the produce of pastures by the application of nitrogenous manures was fully realised.

In the second place, the chemist is now in a position to ascertain the effects of various treatments of the pasture upon the nature, amount and relative proportions of the nutritive ingredients contained in the herbage, whereas this was not possible at the beginning of the nineteenth century.

Early in 1928 arrangements were made to carry out a trial with the new system at the College Farm, Nantcellan, Aberystwyth. The 24-acre field selected for the purpose had been under grass for over thirty-five years.

Nature of Soil.

A relatively narrow strip of about five acres in area along the west side of the field consists of fairly light sedentary soil of a shaly nature on the silurian formation. Over the remainder of the field the soil is a typical boulder clay which in the main is of a tenacious character and very impervious to water. The following table indicates the chemical and mechanical composition of the two types of soil, and the subsequent table shows the botanical nature of the herbage at the time the trial was commenced.

TABLE I.

Mechanical and chemical composition of the soil.

	Sedentary.		*Boulder Clay.*	
	Soil.	*Subsoil.*	*Soil.*	*Subsoil.*
	%	%	%	%
Fine gravel ...	12.4	14.4	1.0	0.0
Coarse sand ...	7.6	7.8	2.2	0.3
Fine sand ...	16.9	17.1	12.8	9.2
Silt ...	12.2	10.6	14.4	15.3
Fine silt ...	24.0	26.9	35.7	35.5
Clay ...	11.0	10.9	15.4	28.2
Moisture ...	2.8	1.7	2.5	1.6
Loss of ignition ...	13.1	8.9	14.7	9.8
Nitrogen ...	0.442		0.481	
Potash (K_2O) ...	0.55		0.65	
Phosphoric acid (P_2O_5) ...	0.26		0.22	
*Available potash ...	0.034		0.026	
*Available phosphoric acid ...	0.032		0.028	

Soluble in 1% citric acid.

At the commencement of the trial the lime requirement of the soil, in tons of calcium carbonate per acre, was found to be as follows :—

Sedentary soil	2.17
Boulder clay (northern end)	1.99
Boulder clay (southern end)	2.39

TABLE II.

Botanical composition of herbage, % of tiller estimation. March, 1928.

	Sedentary soil.	*Boulder clay soil.*
	%	%
Lolium perenne (perennial ryegrass)	16.6	24.2
Cynosurus cristatus (crested dogstail) ...	16.6	13.4
Poa trivialis (rough stalked meadow grass) ...	21.5	26.2
Agrostis spp. (bent)	9.6	8.4
Holcus lanatus (Yorkshire fog)	15.3	12.2
*Other grasses	8.2	6.8
†Trifolium repens (white clover)	6.2	5.0
‡Other legumes	0.1	0.1
†Weeds	5.9	4.2
	100.0	100.0

* Cocksfoot, tall fescue, meadow fescue, fine leaved fescue, sweet vernal grass, autumn meadow grass.

† Daisy, ranunculus spp., self-heal, yarrow, plantain, mouse-ear chickweed, dandelion, carnus spp., catsear, carex spp., juncus spp., ox eye daisy, sorrel dock, luzula spp.

‡ Bird's foot trefoil, yellow suckling clover, red clover.

Manurial Treatment.

The field was divided into seven plots in such a manner as to include the same relative proportions of sedentary and of boulder clay soils in each plot. It was only in the matter of size that there was any difficulty experienced in arranging for the conditions to be the same for all plots. As a matter of convenience in regard to gateways and water supply it was found necessary for plots 1, 3 and 7 to be 4 acres and plots 2, 4, 5 and 6 to be 3 acres in area.

The whole field during the winter months 1927-28 received a dressing of 4 cwt. per acre of basic slag (36% phosphate) and 2 cwt. per acre of potash manure (30% potash). A dressing of 1 ton per acre of waste carbonate of lime, containing approximately 78% of calcium carbonate, was applied on an area of 12 acres. The limed area was the same in each plot, and it was also arranged in a manner that would provide an opportunity of observing possible effects on both the clay and the sedentary soils.

The nitrogenous manuring during the season is shown in Table III.

TABLE III.

Dressing.	*Plot* 1.	*Plot* 2.	*Plot* 3.	*Plot* 4.	*Plot* 5.	*Plot* 6.	*Plot* 7.
1st	S/A Feb. 14	N/C Feb. 21	S/A Feb. 28	N/C Feb. 28	S/A Mar. 13	N/C Mar. 13	S/A Mar. 18
2nd	S/A Apr. 6	N/C Apr. 6	N/C Apr. 30	S/A May 11	S/A May 19	N/C May 15	N/C May 11
3rd	S/A May 24	N/C May 28	S/A July 6	N/C July 6	S/A June 20	N/C June 20	S/A June 20
4th	N/C June 20	N/C July 6	N/C Sept. 6	S/A Sept. 6	S/A Sept. 20	N/C Sept. 20	N/C Sept. 20
5th	S/A Aug. 24	N/C Aug. 25					

S/A = 1 cwt. per acre of sulphate of ammonia (20% nitrogen).
N/C = 2 cwt. per acre of nitro-chalk (10% of nitrogen).

In the case of the last two dressings of the nitrogenous manures portions of the plots were left untreated for comparison.

Number of Dressings and Time of Application of Nitrogenous Manures.

When the trial was commenced it was proposed to apply only three dressings of nitrogen during the season, and, in accordance with information received from other centres, the first dressing was to be applied on Plot 1 at the end of January and about a week later in succession from plot to plot so that Plot 7 would receive its first application about six weeks later than Plot 1. Owing to the wet weather however Plot 1 did not receive its first dose of nitrogen until the middle of February, and, judging from the results, there seem to be indications that it would have been much better if the first application had been delayed until the end of the month. At the beginning of April it was observed that the plots which had received nitrogenous manure towards the end of February or during March were responding well to the treatment, but on Plot 2 and particularly Plot 1, which had been dressed earlier, there seemed to be no appreciable response. Consequently on April 6th a second application was given to these latter plots, and this produced immediate and well marked results similar to those observed on the plots which had their first dressing at the end of February or during March.

It is possible, therefore, that under the conditions of the trial, with a heavy soil saturated with water and a long period of wet weather, it may not be advisable to apply soluble nitrogenous manures as early in the season as appears to be practicable under more favourable conditions. It may be that much of the nitrogenous manure applied as a first dressing to Plot 1 and Plot 2 was washed away along the surface of the wet ground. This uncertainty as to the best period for applying the first dressing of nitrogen in the spring in order to obtain the maximum benefit of an early bite points to the need of further investigations under various Welsh conditions of soil and season. Further reference to the number of dressings of nitrogen will be found in connection, more particularly, with the discussion of the results obtained from different plots (Table VII).

Comparative effects of Sulphate of Ammonia and Nitro-Chalk.

In the case of the second dressings on Plots 1 and 2 and the first dressings on Plots 4 to 7 (Table III), the nitro-chalk was distinctly superior to sulphate of ammonia as regards both the colour and the bulk of the herbage produced. In none of the subsequent dressings, however, was there any observable difference in the effects of the two manures. Consequently, if the matter be considered from the economic standpoint it would appear that there might be an advantage in adopting nitro-chalk for the first application to all plots and using sulphate of ammonia for any subsequent dressings throughout the season, especially if the price per unit of nitrogen and other conditions happen to be favourable to such procedure.

Stock carrying capacity of the Trial Area.

In giving a trial to the new system with grassland it was decided that the " leaders " with the grazing should be the dairy cows. Fattening bullocks were also included with the leaders for a short period but not to the extent that might be considered essential to arrive at reliable conclusions as regards the influence of the system on this type of stock.

The " followers " consisted mainly of heifers under two years old, while sheep and horses made up the greater part of the remainder of this category of grazing animals placed on the plots.

The following table may serve to give some idea of the " grazing " obtained from the whole field during the period April 18th to November 27th inclusive.

TABLE IV.

Stock-carrying capacity from April 18th to November 27th.

Type of Stock.	*Total grazing days.*		*Conversion factor.*		*Number of cow days.*
Cows in milk	3557	×	1	=	3557
Cows suckling calves	44	×	1	=	44
Dry cows	41	×	1	=	41
Heifers in calf	76	×	0.8	=	60.8
Heifers over 2-year old not in calf ...	19	×	0.8	=	15.2
Heifers under 2-year old	2103	×	0.6	=	1261.8
Bullocks under 2-year old	165	×	1	=	165
Heifers under 1-year old	58	×	0.5	=	29
Sheep	1785	×	0.15	=	267.75
Lambs	171	×	0.05	=	8.55
Horses	215	×	1	=	215
			Total	...	5665.10

In the case of sheep and of cattle, other than dairy cows and heifers in calf, the conversion factor to estimate the number of cow days was based on the live weights of the animals. For example, the sixteen heifers under two-year-old which were followers during the greater part of the grazing season averaged 666 lb. live weight when passed over the weighbridge on July 26th. Thus an estimate of the cow days in terms of an approximately 10 cwt. cow is obtained by utilising a conversion factor of 0.6 with this class of stock.

From Table IV it will be found that the 24 acres provided the calculated equivalent of 5,665 cow grazing days, or in other words 286 cow days per acre.

In order to utilise grassland to the best possible advantage the question of distribution of the grazing days as uniformly as possible over as long a season as practicable must be considered. With an intensive system of management the more the grazing days are concentrated into the mid-season grazing months the greater will be the tendency for the farmer to encounter difficulties which may arise from a shortage of winter fodder to balance a surplus of summer food supplies. On the other hand, the problem of winter keep and management will be very largely solved if the system can be worked in a manner that will materially increase the number of grazing days at both ends of the summer season.

In Table V it is shown how the grazing days were distributed from April 18th to November 27th in the trial under consideration. The results are given in terms of cow days per week throughout the period.

TABLE V.

Weekly distribution of grazing days. April 18th to November 27th.

Week commencing.	*Cow days.*	*Week commencing.*	*Cow days.*
April 18	131	Aug. 8	127.6
,, 25	141	,, 15	148.4
May 2	189.4	,, 22	170.9
,, 9	204.8	,, 29	243.6
,, 16	219.2	Sept. 5	218.6
,, 23	285.8	,, 12	109.6
,, 30	264.5	,, 19	177.8
June 6	246.2	,, 26	99.6
,, 13	247.7	Oct. 3	119.3
,, 20	202.5	,, 10	87.3
,, 27	106.2	,, 17	167.9
July 4	246.5	,, 24	171.5
,, 11	262.2	,, 31	141.9
,, 18	264.7	Nov. 7	194.7
,, 25	135.5	,, 14	88.35
Aug. 1	248.4	,, 21	50.28

It will be seen from Table V that the grazing as estimated in terms of cow days is fairly well distributed over the season. The cow days for the last four weeks of October, for example, amount to over 70% of the cow days for the period of four weeks in June. It must be admitted however, that the period of drought which extended over the greater part of the spring and early summer lowered production during June and the early part of July very considerably. At the same time experience with the new system seems to show that much may be done by appropriate management to influence the distribution of the grazing days over the season. Possibly the most important controlling factors in this connection are (*a*) the number and times of application of the nitrogenous dressings, (*b*) the degree of closeness of the grazing at various periods, (*c*) the type of animals used for the grazing, and (*d*) the number of plots available for the rotation.

TABLE VI.

Monthly Rainfall, 1928.

Month.	*Total rainfall ins.*	*Month.*	*Total rainfall ins.*
January	7.44	July	8.89
February	3.84	August	6.73
March	1.99	September	2.15
April	1.14	October	6.62
May	.67	November	6.96
June	5.62	December	4.16

Total rainfall 1928 = 51.21

Relation of weather and closeness of grazing to supply of grass.

There are several interesting features in connection with the distribution of rainfall during 1928 which should not be overlooked in considering the results of the trial. Table VI shows the monthly rainfall for the year as recorded at the Welsh Plant Breeding Station situated about 1½ miles from the College Farm.

The most obvious features of the figures given in Table VI are the high total rainfall for the year and the particularly low values for the three consecutive months March, April and May. When the weekly records are examined they are found to be even more striking than the monthly records, and they illustrate also much more clearly the bearing of the season's weather upon pasture productivity during the summer. The weekly records are very high from the beginning of January up to the end of the third week in February. The point to be emphasised in this connection, however, is that from February 22nd up to June 5th, a period of fifteen weeks, the total rainfall only amounted to 4.19 inches. Further, although the weekly records show a rainfall of 2.87 inches from June 6th to June 19th this had no appreciable effect on the plots in the grazing trial owing to the extreme hardness and dryness of the soil. It was not until the last few days of June or the beginning of July that the conditions as regards soil moisture became favourable to a fair amount of growth.

The conditions as regards rainfall indicated above affected the grazing results in various ways, both directly and indirectly. In the first place there was the ordinary shortage of grass in consequence of the long period of drought. In addition, in view of the recommendations usually made in connection with the New System of Management the plots had been fairly closely grazed from the commencement of the season and were grazed rather severely in June. Careful observations made from this time onwards showed very clearly that the plots and the portions of plots which were most closely grazed were very much slower in providing subsequent growth. It thus appears that, under the conditions of the experiment, close grazing should not be carried beyond a certain limit, otherwise the productive capacity of the pasture may be lowered very considerably. Observations made on all plots throughout the season would seem to indicate that in order to get maximum produce it would be better for the grazing not to be done more closely than the cutting usually effected by the mowing machine even when it is not set very closely.

Influence of size of plots on produce.

In dividing the trial area into seven plots it was found most convenient to arrange the fences along lines that provided an area for each plot as indicated in Table VII. All plots were as similar as possible in type of soil and other natural conditions affecting productivity. The only variation of importance in the treatment of the plots was that indicated in Table III regarding number, nature and times of application of the nitrogenous dressings. In order to ascertain whether this variation in treatment had any material effect, the produce from the different plots was calculated in terms of cow days in the grazing. The results are given in Table VII.

TABLE VII.

Produce per plot.

Plot. No.	*Area of plot. Acres.*	*Cow days per plot.*	*Cow days per acre.*
1	4	801.2	200.3
2	3	781.8	260.6
3	4	888.0	222.0
4	3	715.35	238.45
5	3	791.5	263.8
6	3	786.05	262.01
7	4	900.5	225.1

Examination of the figures given in Table VII, together with the statement in Table III regarding manurial treatments, shows no appreciable difference in pasture yields per acre between the nitro-chalk and the sulphate of ammonia plots, when the grazing for the whole season is taken into consideration. This is in keeping with the statement already made that only with the first dressing given in the spring was there any observable superiority of the nitro-chalk, and evidently this was not of a magnitude that would cause any very striking difference in the total yield of the season. At the same time it should be borne in mind that even a relatively slight superiority at the commencement of the season is of considerable practical value.

Table VII also tends to confirm the view already expressed, that but little, if any, beneficial effect was obtained from the first nitrogenous dressing given in Plots 1 and 2.

Possibly the most interesting feature of Table VII is that it seems to indicate a distinct superiority of the 3-acre over the 4-acre plots in cow days per acre. The average results show that the 3-acre plots provided 256.1 and the 4-acre plots 215.8 cow days per acre. This represents increased keep to the extent of

18.7% in favour of the smaller plots. Assuming the difference is not merely accidental, it is possible that it may be due to the influence of more than one factor. The greater the area of a plot the greater will be the opportunity for selective grazing, thus tending to cause increased difficulties to secure clean grazing by the followers. In addition, variation in the size of the plots included in the rotation system tends to introduce difficulties in the management, more especially in regard to the movement of leaders and followers in orderly succession from plot to plot. It happened on several occasions in the course of the trial under consideration that the leaders had to be moved from a 4-acre plot earlier than had been anticipated in order to get the followers in from the preceding 3-acre plot which had run short of keep. It would appear that the greater the disparity between the plots in area the greater will be the complications in the management during the season, if all the plots are to be grazed to the best possible advantage and all classes of live stock are to be provided with the most favourable conditions for production.

Chemical composition of the herbage.

Several works already published have demonstrated the superiority of the leaf over the stem of grasses as regards nutritive value (2). It has also been shown that the chemical composition of pasture grass may be largely influenced by manuring (3). In the course of the trial under review samples for complete analysis were taken from each plot before the entry of the leaders in the case of every rotation throughout the season. Separate samples were taken from the plots to ascertain the influence of such factors as the following :—(*a*) soil, boulder clay and sedentary; (*b*) application of lime; (*c*) number, nature and time of application of dressings of nitrogenous manures; (*d*) stage of growth at the time of entry of leaders to plots; (*e*) time of the year.

Over 200 samples were taken during the season. It will be necessary to continue the work for two or three years at least before it is possible to accummulate enough data to provide information of value in connection with most of the problems under consideration, particularly those which may be regarded as of greatest fundamental importance. It may be of interest however, to make a very brief statement concerning a few of the results already obtained.

In order to provide some idea of the change in composition during the season, results obtained in the analysis of samples of the herbage taken on the sedentary soil area of Plot 5 are given in Tables VIII and IX.

TABLE VIII.

Percentage composition of dry matter.

Date of sampling.	*Crude protein.*	*True protein.*	*Ether extract.*	*Crude fibre.*	*Ash.*	*Soluble carbohydrates.*
April 26	20.51	16.50	6.70	15.30	8.80	48.69
May 7	15.80	13.30	5.45	21.15	8.80	49.30
June 7	16.24	13.91	4.33	26.67	8.35	44.41
July 9	17.24	12.99	4.10	32.00	11.85	34.81
August 8	18.81	9.98	2.95	25.25	10.40	42.59
Sept. 8	21.09	17.41	3.50	25.30	10.15	39.96
Oct. 15	22.66	17.23	3.05	24.15	10.25	39.89

TABLE IX.

Composition of Ash.

(Expressed on basis of dry matter).

Date of sampling.	*Silica.*	*Silica free-ash.*	*Phosphoric acid.* (P_2O_5)	*Lime.* (CaO)	*Potash.* (K_2O)	*Chlorine.* (Cl)
April 26	1.25	7.55	0.975	0.995	3.67	1.510
May 7	1.35	6.95	0.718	0.980	3.56	1.380
June 7	1.85	6.50	0.612	1.043	2.50	1.100
July 9	3.10	8.75	0.978	1.110	4.41	1.419
August 3	2.10	8.30	0.980	1.162	3.93	1.366
Sept. 3	1.85	8.30	0.924	0.896	4.03	1.382
Oct. 15	2.75	7.50	0.956	0.798	3.98	1.366

The figures given in Tables VIII and IX show that the chemical nature of the herbage obtained by this intensive treatment was, speaking generally, somewhat similar to that of some of the best types of pastures in Central Wales. They also indicate that the October grass was in many respects distinctly satisfactory in quality. In fact the protein content of many of the samples taken in October was higher than that of a number of samples taken at the commencement of the season. It was the May and June pasture that proved to be the lowest in protein content. The prosphoric acid was decidedly lower in June than at any other time of the season. The ether extract diminished fairly regularly until August, but showed a tendency to increase slightly during the autumn. In general the analyses seemed to indicate that the new system helps to provide " keep " of good quality during the autumn and early winter, and good progress made by the live stock while grazing on it during the back end of the season appeared to be in keeping with the analytical results.

The chemical composition of the herbage actually consumed by the stock varied considerably, not only according to the time of the year but also in accordance with the stage of growth of the pasture at the time of grazing. Table X shows the composition of samples taken from Plots 1, 7 and 5 shortly before the entry of the leaders in the first rotation.

TABLE X.

Influence of stage of growth on chemical composition.

Plot.	*Date of sampling.*	*Crude protein.*	*Ether extract.*	*Crude fibre.*	*Ash.*	*Soluble carbohydrates.*
1.	April 16	27.07	6.50	16.00	9.25	41.18
7.	April 30	23.71	4.50	21.48	8.02	42.29
5.	May 7	15.80	5.45	21.15	8.30	49.30

The above Table gives some idea of the rate at which pasture may alter in its chemical nature. Plot 1 was the first and Plot 5 the last to be grazed in the rotation. It will be observed that in the period of three weeks which intervened between the first grazings of Plot 1 and Plot 5 the protein content of the pasture was lowered nearly to a half.

Influence on botanical composition of the herbage.

It is too early as yet in the course of the trial to form any definite opinion as to what is likely to be the influence upon the character of the sward. Up to the present, however, there does not seem to have been any appreciable change as far as the grasses and clovers are concerned. It may be mentioned, however, that the effect on rushes, and particularly on thistles, has been very marked. In fact they have been almost entirely eradicated in the course of the first year with the trial. In previous years rushes and especially thistles flourished in spite of systematic and repeated cuttings. This year, owing to the earliness of the first grazing and the extremely succulent nature of all constituents of the herbage, the thistles were kept down from the commencement of the season by the browsing action of the animals.

The System in its effects on live stock.

It may be stated in a general way that all classes of live stock that were used for the grazing thrived well on the pasture throughout the season. The dairy cows which acted as leaders added on an average half a hundredweight to their live weight during the first month after going out to grass and kept in very good condition throughout the summer. A total yield of

81,178.5 lb. of milk was obtained from the herd while grazing on the trial area, which is equivalent to about 338 gallons per acre. This is exclusive of the milk obtained when the cows were away from the plots as, for example, when they were grazing the aftermath in other fields. It should be noted also that, as indicated in Table IV, the cows-in-milk represented only about 60% of the stocking during the season. Reference to the influence of the herbage on the composition of the milk is made in another article in this issue of the Journal (4).

In regard to the followers also it may be stated that there was satisfactory performance throughout. For example, the sixteen heifers under two-year-old to which reference has already been made in connection with Table IV showed progress in live weight during the season as shown in Table XI.

TABLE XI.

Live weight progress of sixteen yearling heifers.

Weighing dates.	*Average weight (lb.).*	*Average increase (lb.).*	*Average daily gain (lb.).*
May 7	536	—	--
June 6	616	+ 80	2.66
June 29	626	+ 10	0.44
July 26	666	+ 40	1.47
Aug. 31	710	+ 44	1.26
Oct. 5	748	+ 38	1.10
Nov. 8	776	+ 28	0.80

The first weighing indicated above, May 7th, was done a week after the heifers had started grazing on the plots. As a rule the weighings were made at 9 a.m., the animals being taken directly from the plots on to the weighbridge.

The figures indicate a very rapid increase in live weight during May but only a very small increase in June. There appear to have been two reasons for the unsatisfactory progress during the latter month :—

1. The long drought had led to a scarcity of keep on the plots (c.f. p. 90).
2. An effort was made at this time to get a real close grazing by penning the followers on the plots for a longer period than usual.

The behaviour and general appearance of the animals seemed to be in agreement with the weighbridge evidence as regards unsatisfactory progress during June. Consequently from this time onwards the strict observance of the practice of close grazing was abandoned, as it was felt essential to have satisfactory progress in live weight in the case of yearling heifers in order to produce useful and well developed dairy cows. Thus it was decided that the trial with the new system was to be made under conditions that provided amply not only for maintenance but also for satisfactory production in the case of the " followers " as well as the " leaders ". In other words the new system was made to suit the stock and not the stock to suit the system. It would have been possible to have increased the number of cow grazing days with the followers very considerably by penning such a number of animals on the plot as would be able to obtain only a maintenance ration.

Judging from the experience indicated above with the followers it seems very questionable whether it is always wise to pen followers on a plot with a view to securing clean grazing of a few tufts of grass which appear to be disliked by stock. Observations made seemed to indicate that :—

(*a*) The followers at first grazed the portions of the plots already grazed well by the leaders until they were quite bare.

(*b*) Subsequently the outside and the tops of the tufts were grazed and the animals became very discontented with their lot.

(*c*) The really hard grazed portions of the plots were, as already stated, slow in recovering, thus upsetting the smooth working of the system of rotation.

Mechanical treatments.

As a matter of convenience a number of operations usually recommended in connection with the working of the new system may be considered together.

In order to obtain the best results with the system it is usually stated that the land should be well rolled in the spring and possibly at other times of the year with a view to getting the ground well consolidated. Harrowing also is much advocated. It is often suggested that the ground should be well harrowed in the spring, and that in every rotation throughout the season each plot should be harrowed after the removal of the followers. This recommendation is usually made on the supposition that harrowing is effective in spreading the droppings and hindering the development of patches of rank unpalatable herbage. In the trial under review, however, no rolling was done, as the soil was considered to be sufficiently well consolidated. The experience gained during the season did not provide any indications of much benefit to be derived from the practice of repeated harrowings. In fact it was found that the spreading of the droppings by harrowing at times resulted in long streaks of soiled grass and increased difficulty to secure uniform grazing.

Mowing of any stemmy herbage which may remain after the followers is another operation that is often strongly urged. In this trial a certain amount of mowing was needed during June and July. During the remainder of the season, however, there did not appear to be much difficulty to control the grazing in such a manner as to avoid the need of any further mowing.

The general impression obtained was that in order to add to the efficiency and practicability of the system there is much need for further investigations in connection with the mowing and the mechanical treatments, both as regards the extent to which they are needed and the manner in which they should be performed.

Balance of summer and winter keep.

One of the objections often raised against the Intensive System of Grassland Management is that while it increases the stock carrying capacity of the farm during the summer season it does not provide the requisite additional food for wintering the stock. Experience with the system seems to indicate that this objection is more apparent than real. With proper management it does not appear that there should be much difficulty in meeting the winter requirements. In the first place, it should be borne in mind that the system extends the grazing season at both ends. In this particular trial the treatment made it possible for the dairy cows to be dependent upon the pasture on the plots three weeks earlier than would have been the case with the ordinary system of management. Further, horses, cattle and sheep were out on the pasture and entirely dependent upon it up to the end of the year. In fact the trial area provided keep to the extent of 285.2 cow days between November 27th and the end of December. It is of interest to note that the pasture responded well during the winter months to the last nitrogenous dressing given during the autumn (August 24th to September 20th). This was made evident by the fact that the pasture on the treated areas presented a marked contrast in appearance to that on the untreated areas. It is thus obvious that with the adoption of the new system much less winter fodder is needed per head of stock kept. In addition, it is possible to extend the area under hay, and this facilitates matters very considerably in dealing with the needs of any extra stock during the winter season.

Experience obtained in the course of a year's working with the new system has served to demonstrate quite clearly that it can be made the means of largely increasing the productivity of grassland. There are, however, several important features as regards both treatment and management which need further investigation in order to evolve suitable modifications of the system to meet the requirements of different farming conditions. Undoubtedly on many farms in Wales the new system, in the form in which it is usually advocated, might be practicable and profitable. Probably on many more farms some modified form of the system would be likely to answer a good purpose. Possibly one of the most useful lines along which many Welsh farmers might endeavour to apply some of the principles involved in the system is by way of making an attempt to provide an "*early bite*", on a portion of the pasture area, for sheep and lambs in the spring. On a great many holdings in Wales, one dressing of nitrogenous manure on some of the pasture land would provide much earlier and better keep for the sheep. In addition, this procedure would enable the farmer to deal more justly with his hay land by having the fields "*closed up*" at an earlier date. In this way the flock would benefit directly in the spring time and the herd would benefit indirectly during the following winter.

It will be observed that no mention has been made of the results of the trial as viewed from the economic standpoint. It is considered that several years' experience will be needed before it is possible to arrive at any satisfactory conclusions in regard to this aspect of the system.

The writers wish gratefully to acknowledge their indebtedness to members of the staff of the Agricultural Chemistry Department of the College for all the chemical work involved in connection with the trial, and to members of the staff of the Welsh Plant Breeding Station for data regarding rainfall and work on the effects of the system upon the botanical nature of the herbage. It is only with their loyal co-operation that it is possible to continue with this work in a manner that may help to provide information which will indicate how the system may be adapted to the various farming conditions obtaining in Wales.

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THE NUTRITIVE VALUE OF PASTURE GRASS AS INFLUENCED BY MANAGEMENT.

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The constituents of a foodstuff usually taken into consideration when its nutritive value is assessed are ether extract or oil, albuminoids or proteins, carbohydrates and fibre. In grass we find representatives of each of these groups of compounds, though as a foodstuff grass is characterised by the high percentage of water it contains, which makes up from 80 to 85% of the whole.

The dry matter of grass on the other hand resembles the majority of home grown foods in its richness in carbohydrates but differs from them in containing a high percentage of albuminoids. It is unnecessary to elaborate on the part played by these different groups of compounds in animal nutrition, for readers of the *Journal* will be familiar with this. It may not be out of place however, to remind them that the price of a concentrated food is largely governed by the percentage of oil and albuminoids it contains, these being the constituents guaranteed in a concentrated food. Further, except for some special reason, preference is shown by buyers for decorticated over the more fibrous undecorticated foods.

From these facts an indication is obtained of the constituents of a foodstuff that are looked upon with favour, as well as that which when present in excess is not so desirable. If, therefore, by any system of management we are able to increase in grass the desirable constituents and to decrease the less desirable it will be admitted that something has been done towards the improvement of the produce of our grassland.

The first point in this connection to which attention might be drawn is the influence frequent cutting has on the nutritive value of grasses and clovers as shown by their chemical composition. Although differing from close grazing in that the discrimination shown by the animal is absent, yet it is a sufficiently close imitation to indicate the main effect of close grazing on the nutritive value of the produce—see Table I below.

The cocksfoot was grown in one plot, a portion of which was cut every fortnight and the other every month. From the Table it is seen on comparing the percentage of ether extract, albuminoids and fibre in the grass cut at fortnightly and monthly intervals that the fortnightly cut grass contains a higher percentage of ether extract, and that on the average it contains 5% more albuminoids and approximately 5% less fibre. It is thus seen that the chemical composition of grass is largely dependent on its stage of growth, for the younger it is, or, in other words, the more closely it is grazed the more succulent and nutritious it is in consequence.

TABLE I.

Gives the percentage of ether extract, albuminoids and fibre in Cocksfoot cut at fortnightly and monthly intervals (expressed on basis of dry matter).

Date of Cutting.	*Ether extract or oil.*		*Albuminoids.*		*Fibre.*	
	Fortnightly Cut.	*Monthly Cut.*	*Fortnightly Cut.*	*Monthly Cut.*	*Fortnightly Cut.*	*Monthly Cut.*
May 8, 1921	4.24	3.80	22.12	21.81	21.55	22.50
,, 17, 1921	3.91		21.06		22.10	
,, 31, 1921	3.76	3.18	21.94	13.75	21.00	26.20
June 14, 1921	3.09		20.68		19.35	
,, 28, 1921	3.20	3.01	19.69	12.06	20.50	21.60
July 12, 1921	4.68		17.06		19.00	
,, 26, 1921	4.70	3.22	17.75	13.62	17.00	22.68
Aug. 9, 1921	5.31		26.44		16.00	
,, 23, 1921	5.52	3.47	25.75	22.68	16.50	23.95

The same applies to clover, as shown in Table II.

TABLE II.

	Ether extract or oil.		*Albuminoids.*		*Fibre.*	
	Weekly Cut.	*Monthly Cut.*	*Weekly Cut.*	*Monthly Cut.*	*Weekly Cut.*	*Monthly Cut.*
May 26, 1927	3.07	2.00	28.29	26.21	14.60	14.91
June 2, 1927	3.65		28.96		15.55	
,, 9, 1927	3.00		28.49		18.10	
,, 16, 1927	3.71		26.15		17.95	
,, 23, 1927	2.94		22.87		16.80	
,, 30, 1927	3.05	2.95	26.84	24.41	17.05	17.50
July 7, 1927	3.10		28.05		18.30	
,, 14, 1927	3.45		26.62		19.00	
,, 21, 1927	3.20		26.18		19.45	
,, 28, 1927	3.87	3.20	25.50	23.29	16.60	20.95

The results shown in Tables I and II prove beyond doubt that the chemical composition of the produce of a grass or clover cut frequently as compared with that cut at longer intervals is richer in those constituents that are desirable in a foodstuff and contains a lower percentage of that (fibre) which is not so desirable. This being so, may it not be a possible explanation of what most practical men are familiar with, namely, the thriving appearance often shown by stock on relatively poor pastures, while others on pastures where the grass is plentiful do not appear to do so well. Though, as already shown, the chemical composition of a grass or clover cut at frequent intervals is superior to that cut at less frequent intervals, it has to be remembered that the greatest amount of nutrients—that is, food material of use to the animal—is obtained from the produce of the longer period of growth rather than from the sum of the produce of the shorter periods.

This is shown in Table III, which gives the yield of dry matter, albuminoids and fibre of Italian rye grass under a weekly and monthly system of cutting.

TABLE III.

Week ending.	*Yield in lb. per acre.*					
	Weekly Cutting.			*Monthly Cutting.*		
	Dry matter.	*Albuminoids.*	*Fibre.*	*Dry matter.*	*Albuminoids.*	*Fibre.*
April 13	31*	6.1*	6.1*			
,, 20	28	7.5	5.7			
,, 27	31	7.3	6.3	361	65.9	75.7
Total for month	90	20.9	18.1	361	65.9	75.7
May 5	34	8.3	7.2			
,, 12	31	7.6	8.0			
,, 19	42	9.1	10.1			
,, 26	21	4.2	4.9	744	101.7	155.9
Total for month	126	29.2	30.2	744	101.7	155.9

* Represents a fortnight's growth.

The Table shows the monthly yield in April and May to be four and six times respectively the sum of the weekly yields in these months, and that this superiority in yield more than counterbalances the difference in chemical composition in favour of the weekly system of cutting. On the other hand, under grazing conditions a month's growth would be subjected to the trampling and uneven grazing of stock resulting in considerable waste, whereas a week or a fortnight's growth would suffer much less in comparison. The point at which the maximum benefit is to be derived from the produce of a pasture would appear to be intermediate between these two systems of management. From unpublished data obtained at the Welsh Plant Breeding Station with sheep, the greatest live weight increase as well as greater keep for followers was obtained by a monthly system of grazing. The time at which to graze, however, each individual farmer much decide for himself, being guided by the growth on the pasture. What must be guarded against is allowing the growth to become rank, or in other words allowing quality to be altogether sacrificed for bulk.

Frequent cutting or close grazing has been shown to have a very considerable effect on the character of the herbage of pastures. Thus the more frequently a grass or clover is cut or grazed the higher the proportion of leaf to stem in the produce.

Table IV gives the ratio of stem to leaf and the chemical composition of each of these in a weekly and monthly cut of Italian rye grass taken on June 30th, 1927.

TABLE IV.

	Weekly Cut.		*Monthly Cut.*	
	Ratio of stem to leaf 1 : 3.5		*Ratio of stem to leaf* 1 : 2.4	
	Stem.	*Leaf.*	*Stem.*	*Leaf.*
Ether extract or oil	2.35	2.90	2.00	3.40
Albuminoids	17.03	25.57	11.11	14.87
Fibre	25.40	21.45	33.40	24.40

The Table shows that the proportion of leaf is much higher in the weekly than the monthly cut. Further, that the composition of the leaf in both weekly and monthly cuts is superior to that of the corresponding stem, but that the composition of the stem in the weekly cut closely resembles even that of the leaf of the monthly cut.

It is clearly seen from Table IV that any method of management that results in a more leafy herbage in our grass-land is one to be particularly aimed at, and that one means by which this may be accomplished is by careful attention to the management of the grazing.

An appreciable proportion of the herbage of many of our pastures is made up of Yorkshire fog and bent, and though neither of these are encouraged, being usually regarded as weeds, their presence in a pasture makes its management a matter of some importance if the maximum amount of nutrition is to be obtained from them. One method of effecting this is to keep such pastures closely grazed, and if the stock is not heavy enough to cope with their luxuriant growth, then the advisability of running the mowing machine over them should be considered. The effect of frequent cutting or close grazing on the chemical composition of these two grasses is shown in Table V.

TABLE V.

Gives the percentage of ether extract or oil, albuminoids and fibre in monthly pasture cuts of Yorkshire fog, bent, and for comparison, cocksfoot (expressed on basis of dry matter).

	Yorkshire Fog.	*Bent.*	*Cocksfoot.*
Date of cutting.	11/4/24	11/4/24	11/4/24
Ether extract ...	3.68	3.54	4.63
Albuminoids ...	23.88	18.86	24.31
Fibre ...	16.06	23.04	22.25

The three grasses in the above Table were all treated in a similar manner and cut at monthly intervals. From the Table it is seen that Yorkshire fog and bent when kept in subjection by hard grazing or frequent cutting may be made to contribute very materially to the nutritive value of the pastures in which they occur, and judged by their chemical composition compare favourably with such a grass as cocksfoot.

Another method by which the nutritive value of pastures may be increased is by the application of manure. Thus it is a well recognised fact that nitrogenous manure when applied to pasture increases the yield and encourages the growth of the vegetative part of the herbage.

Experiments on the effect of the application of nitrate of soda to cocksfoot were carried out in Aberystwyth in 1924.[1] As a result of a single application of the manure there was an unmistakeable increase in yield, but no appreciable increase in the proportion of leaf to stem. Chemical analysis of the produce of the pasture cuts receiving nitrate of soda, however, showed a marked increase in albuminoids compared with the control plot, an increase that is of special interest and importance when the extra yield following the application is also taken into consideration. In 1927 more elaborate experiments were laid down at Aberystwyth to investigate the effect of nitrate of soda on individual grasses, temporary leys and on well established pastures. Without going into a detailed account of these experiments it may be said with regard to the individual grasses that as a result of the application of the manure their yield in every case was increased and the percentage of albuminoids very considerably raised.

In the case of the temporary ley, where Italian and perennial rye grasses with Montgomery late flowering red clover were sown, the application of nitrate of soda at the rate of 8¾ cwts. per acre in dressings of ¾ cwt. at a time increased the yield of both grasses and clovers, but the grasses to a larger extent than the clovers.

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[1] *Welsh Journal of Agriculture*, Vol. II, page 113.

Table VI shows the effect of nitrate of soda on the total yield of the dry matter, ether extract, albuminoids and fibre of the six monthly pasture cuts (March—September) of Italian rye grass and clover (expressed in lb. per acre).

TABLE VI.

Control Plot.

Weight of dry matter.	*Ether Extract.*	*Albuminoids.*	*Fibre.*
2613	75.8	415	621

Nitrogen Plot.

Weight of dry matter.	*Ether Extract.*	*Albuminoids.*	*Fibre.*
4236	118.5	746	1022

The nitrate of soda not only increases the yield, but when the yield of the control and manured plots are taken into consideration it is seen that the percentage of albuminoids are considerably higher as a result of the manure. Thus the manure gives an increased yield of produce containing a higher percentage of albuminoids.

The good effect that follows the application of phosphatic manures to pastures and their influence on the growth of clover is well known. What is probably not so well realised is the influence the presence of this clover has on the nutritive value of the produce as shown by its chemical composition.

In Table IV the superiority of the leaf over the stem in chemical composition was shown. In Table VII the chemical composition of the leaf of Italian rye grass and that of the whole cut (stem and leaf) of clover are compared.

TABLE VII.

	Italian rye grass. (Leaf only).	*Montgomery clover. Whole cut (stem and leaf).*
Ether extract ...	2.55	3.05
Albuminoids ...	23.87	26.84
Fibre ...	22.34	17.05

The above represents the chemical composition of a weekly cut of Italian rye grass and Montgomery broad red clover taken on June 30th, 1927. It will be noted that the whole cut of clover, that is stem and leaf is richer in ether extract and albuminoids and contains a lower percentage of fibre than the leaf alone of Italian rye grass. It might be maintained that the comparison is to the disadvantage of the grass owing to the fact that the latter is nearer to the date of flowering than the clover; throughout the series of weekly cuttings, however, it is only on one occasion that the leaf of the grass is richer than the whole cut of clover. There is therefore little doubt that the presence of clover has a considerable effect on the nutritive value of the pasture.

Another means by which the nutritive value of pastures may be increased is by choosing those varieties of grasses that are most leafy. That there is considerable difference in leafiness amongst varieties of the same species of grass, *e.g.*, indigenous and commercial strains of cocksfoot, timothy and tall oat grass, has been demonstrated at the Welsh Plant Breeding Station.[2] Further the indigenous varieties of the same grass were found to produce more nutritious keep as pasture than the commercial, not because of any difference in chemical composition between the stem and leaves of the indigenous and commercial, but because the ratio of stem to leaf is less in the indigenous. The influence this has on the chemical composition of the produce has already been mentioned and illustrated in Table IV.

Our own observations tell us that during the grazing season the feeding value of pastures varies within wide limits, for example, the effect of the early spring bite on all types of stock is well known, especially in the case of dairy cattle. This variation is also shown in the chemical composition of the produce of our pastures, for when a general survey of the composition of the dry matter is taken this is found to have a high value from March to the middle of May. From this to the end of July it is relatively low, rising again in August and September. This fluctuation in value is found to follow closely the proportion of stem to leaf in the produce as shown in Table VIII.

TABLE VIII.

Giving the ratio of stem to leaf in Italian rye grass cut at weekly intervals between April 1st and September 29th, 1928.

Period of growth.	*April 1st to May 12th.*	*May 12th to July 28th.*	*August to September 29th.*
Average ratio of stem to leaf ...	1 : 3.8	1 : 1.9	1 : 4.6

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[2] " The nutritive value of grasses ", by Stapledon. Vol. XXXIV, No. 1, April, 1927, *Journal of the Ministry of Agriculture.*

In the latter parts of June and July many of our pastures resemble hay fields in their general appearance, due to the high proportion of stem to leaf in the growth at this period. The result is that the ration of the grazing animal at this period of the year is abundant but poor in quality, and its poverty is largely due to the preponderance of stem over leaf in the produce. The state of his pastures at this time of the year is a point that should occupy the particular attention of every practical man, and care taken that the growth is not allowed to get out of hand and reach that advanced stage of maturity which it often does in practice.

That both grasses and clovers deteriorate in nutritive value with age is seen in Table IX.

TABLE IX.

No. of weeks' growth.	*Italian Rye Grass.*			*Montgomery Red Clover.*		
	Ether Extract or Oil.	*Albuminoids.*	*Fibre.*	*Ether Extract or Oil.*	*Albuminoids.*	*Fibre.*
5	3.13	25.08	17.45	3.53	26.20	18.30
7	3.20	20.65	21.20	3.25	21.35	21.30
9	2.91	19.29	27.25	2.85	19.82	25.80
11	2.00	16.28	30.90	2.00	17.15	27.65

The above Table shows that with each successive week's growth there is a reduction in the percentage of ether extract and albuminoids, accompanied by a considerable increase in fibre.

There is reason to fear that in the management of many pastures too high a value is often attached to bulk at the expense of quality. A familiar sight on many of our pastures in the latter and early months of the year, especially on those not closely grazed, is the burnt or brown appearance of the herbage, caused by a change of colour in the leaf. As this brown material constitutes a large proportion of such herbage and contributes largely to the bulk of " keep ", a comparison of the chemical composition of the stem, leaf and " burn " of a grass from such a pasture will be of interest.

TABLE X.

Shows the chemical composition of the stem, leaf and "burn" of Cocksfoot cut March 26th, 1923.

	Stem.	*Leaf.*	*" Burn."*
Albuminoids ...	18.00	25.00	11.94
Fibre ...	26.50	23.75	28.57
Ash ...	14.52	10.52	24.66
Silica or sand ...	3.81	3.87	17.45

The " burn " is seen to be of very little nutritive value when compared with the stem and leaf, and to be characterised by a low percentage of albuminoids and high fibre and ash content. When it is pointed out that from 25 to 40% of such pastures is often made up of " burn " it will be readily understood that such foggage cannot have a very high nutritive value.

Stress has been laid on the importance of a leafy herbage in pastures owing to the outstanding superiority of the leaf over the stem in chemical composition, and one or two methods of management have been mentioned by which this may be brought about.

Apart from any figures or results that might be quoted, if we rely on our own observations of what the animal grazes—who after all, is the best judge—we know that he shows a preference for leaf over stem. We need only picture in our minds the appearance of a piece of kale fed off with sheep to assure ourselves of this.

That sheep, and to an appreciable extent cattle, exercise a considerable amount of selection in their grazing has been shown in the evidence gathered by the staff of the Welsh Plant Breeding Station, and in this, as would be expected, palatability plays a very important part. It is therefore interesting to note that sheep select those portions of the pasture which have the highest nutritive value as shown by their chemical composition. Thus it has been observed that it is the younger and more succulent growth and consequently the most nutritious that sheep graze first. The same tendency is shown in the instinctive preference shown by sheep for the leaf portion of a grass over that of a stem.

From what has been said, it will be obvious that the encouragement of leaf development in the herbage of pastures is one of the most important factors in the improvement of their nutritive value.

As a result of research work on the ill effects following the feeding of rations deficient in mineral matter to young animals, a great deal more attention has of late been paid to the mineral content of foodstuffs.

The general belief in our country has been that where an adult is fed on a mixed diet there is little danger of any deficiency of mineral matter occuring. The case however, of young animals, pregnant animals, and animals milking and nursing their young is exceptional. The demands of such animals on the mineral matter of their food, as will be readily understood, are much greater, and special attention to the supply of certain mineral constituents is necessary in order to ensure their well being.

Seeing that mineral deficiencies have been shown to be responsible for many unsatisfactory results in stock raising, and that stock raising occupies the position it does in the agriculture of Wales it is extremely important that any improvement that can be brought about in the mineral content of the herbage of our pastures should not be lost sight of in their management.

A great deal of work has been carried out in Aberystwyth both on the mineral content of different types of pastures as well as that of individual grasses and clovers. An indication of the differences found in the phosphoric and lime content of the dry matter of the herbage of different pastures is shown in Table XI.

TABLE XI.

Type of Pasture.	*Best.*	*Lowland.*	*Ffriddoedd.*	*Sheep Walks.*
Silica-free ash ...	7.74	5.82	3.26	2.48
Phosphoric Acid (P_2O_5)	0.76	0.59	0.44	0.26
Lime (CaO) ...	1.12	0.81	0.39	0.32

The above results represent the average of those obtained from a very large number of samples that have been examined, taken over a considerable area and covering the greater part of Mid Wales.

From the Table it is seen that the lime and phosphoric acid content of these pastures vary widely, and that the richest compared with the poorest contain three times as much phosphoric acid and nearly four times as much lime. The ffriddoedd and sheep walks are seen to be the lowest in mineral content, being rarely dressed with phosphates or lime. These swards are further generally deficient in leguminous plants. Doubtless the wide variations found in their mineral content are responsible for many of the characteristics of the stock that graze them.

Individual grasses show great variation among themselves in their phosphoric acid and lime content, thus cocksfoot, tall oat grass and tall fescue are rich in phosphoric acid, while timothy, meadow foxtail and bent are poor. Again perennial rye grass and red fescue are rich in lime, while meadow foxtail, sweet vernal, timothy and bent are poor in this constituent. It is of interest here to note that bent, associated as it is with much of our poorest grazing land, is poor in both phosphoric acid and lime.

As a result of future research work, it is certain that further light will be thrown on the part played by different minerals in animal nutrition. This will provide us with better guidance in the rationing of farm animals. It will also assist us to understand why, for example, some pastures are famous for their shire horses, while others are renowned for their cheese making qualities.

Judged by the chemical composition of the produce, the main factors that appear to influence the nutritive value of our grassland are :—

(1) More judicious grazing. This results in greater development of leaf, which has a higher nutritive value than the stem. Again, care should be taken that in the summer months the growth does not get out of hand and that in the autumn quality is not sacrificed for bulk.

(2) Manuring. Nitrogenous manures have been shown to have a beneficial effect on the yield and chemical composition of grasses, while phosphatic manures encourage the growth of clover, the presence of which adds considerably to the nutritive value of pastures and to their mineral content, especially lime.

(3) Variety of grass. Indigenous varieties should be chosen in preference to commercial, owing to the former being more leafy.

THE EFFECT OF SUMMER GRAZING ON THE COMPOSITION OF MILK.

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As a result of an investigation carried out in 1926 and 1927[1], it was found that a significant change took place in the concentration of casein and inorganic phosphorus of the milk of a herd of shorthorn dairy cows when turned out to grass. The increase that took place in the percentage of these constituents was seen to depend largely on the system of feeding followed during the previous winter, being greater when the animals had been fed on a ration poor in protein and ash. These changes were, however, only studied with one herd when the feeding conditions were fundamentally the same; that is, the hay in both years was of very good quality, the concentrated food was of a similar nature in both winters, and the pastures at the beginning of the grazing seasons were excellent and abundant. It was therefore thought desirable to determine the changes taking place in the composition of milk under radically different winter feeding and summer grazing.

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[1] *Welsh Journal of Agriculture*, Vol. III, 1927, pp. 236-249; Vol. IV, 1928, pp. 114-121.

In 1928 an entirely different set of conditions presented themselves. The hay, owing to the wet harvest of 1927, was so poor that great difficulty was experienced in maintaining the yield of milk even when liberal allowances of concentrated food were given.

The cows, acting as leaders on the plots included in the rotational grazing trial at the College Farm, were let out to grass on April 18th. It was thought that a study of the milk under these altered conditions might give useful information as to the factors that govern some of the important fluctuations in its composition.

To throw still further light on the changes that may occur in the composition of milk at the commencement of grazing, an additional farm was selected where the cows were changed over from a satisfactory winter ration to exceptionally poor grazing. This was a farm of high altitude where hay of comparatively good quality had been harvested during a rare and short dry interval of the summer of 1927. A prolonged period of drought and cold weather had practically inhibited all growth when the cows were let out in the second week of May.

At the time of transition to summer grass, the milk of three groups of cows was under examination. Each group was fed with a different winter ration. One group received a ration in which good hay was included. A second group received a balanced ration containing hay of poor quality, while a third group received a low protein ration containing the same poor quality hay. The three rations were made up in detail as follows :—

Ration A. *(Ration with good hay).*	*Ration B.* *(Balanced ration with poor hay).*	*Ration C.* *(Low protein ration with poor hay).*
MAINTENANCE.		
14 lbs. hay	20 lbs. seed hay	20 lbs. seed hay
18 lbs. cereal chaff		
15 lbs. swedes		
PRODUCTION OF 1 GALLON MILK.		
2.7 lbs. dairy meal	1.2 lbs. crushed oats	
	1.2 lbs. Indian meal	2 lbs. oats
	0.8 lbs. Palm Kernel cake	2 lbs. maize meal
	0.4 lbs. linseed cake	
	0.4 lbs. earth nut cake	

The amount of digestible protein and total lime and phosphate contained in these three rations is shown in Table I.

TABLE I.

Digestible protein and total lime and phosphate supplied in three winter rations prior to commencement of summer grazing in 1928.

	Digestible protein (lb.)			*Total Lime* (CaO) (oz.)			*Total Phosphate* (P_2O_5) (oz.)		
Ration ...	A	B	C	A	B	C	A	B	C
Maintenance ...	1.36	0.89	0.89	5.99	2.350	2.350	1.74	1.060	1.060
Production of 1 gallon ...	0.45	0.53	0.28	0.232	0.134	0.053	0.519	0.531	0.349
Production of 2 gallons ...	0.90	1.06	0.56	0.164	0.268	0.106	1.038	1.062	0.698
Production of 3 gallons ...	1.35	1.59	0.84	0.696	0.402	0.159	1.557	1.593	1.047
Production of 4 gallons ...	1.80	2.12	1.12	0.928	0.536	0.212	2.076	2.124	1.396

It is seen from the above Table that the maintenance portion of ration A supplied much more protein, lime and phosphate than the other two rations. This was partly due to the superior quality of the hay, but chiefly to the large quantity of cereal chaff that was fed. The proportion of grain to straw in this particular chaff was not determined, but one would expect more than 1 lb. of grain to 2 lbs. of straw even from those varieties giving the lowest proportion of grain yield to straw[2]. This means that the maintenance ration included at least 6 lbs. of oats. It is evident, therefore, that rationing on this basis of cereal chaff cannot be generally recommended from an economical point of view.

Although the production part of ration A closely resembled ration B with respect to protein and phosphate, a three-gallon cow would receive more protein and considerably more phosphate from ration A than ration B owing to the superior quality of the maintenance portion.

It should be pointed out that while the figures for the lime and phosphate are the direct result of analysis, arbitrary digestibility coefficients were used in calculating the digestible protein. Thus the coefficient of 40 was used for the poor quality hay, and 55 for the satisfactory hay. While it is realised that these figures do not actually represent the digestibility coefficients of these hays, it is at the same time considered that they do not exaggerate the difference in quality between them, having regard to their appearance and the marked contrast in the harvesting conditions.

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[2] M. G. Jones. Preliminary Investigations with Oats. *Welsh Plant Breeding Station, Series C,* No. 8, p. 28.

Summer Grazing.

As previously indicated, the cows on ration A were turned out to poor grass, while those on the other two winter rations, viz., B and C, were grazed on the same good quality pasture.

Table II gives the analysis of the two pastures at the commencement of grazing.

TABLE II.

Analysis of pastures at commencement of summer grazing.

	No. 1. Grazed by cows previously on Ration A.	*No. 2. Grazed by cows previously on Rations B and C.*
Crude protein ...	8.13	23.06
Crude fibre ...	28.64	18.29
Ash ...	6.95	8.62
Silica ...	2.59	1.24
Silica free ash ...	4.36	7.38
CaO ...	0.681	1.050
P_2O_5 ...	0.380	0.807

From the above it is evident that the grazing available for the cows on winter ration A was vastly inferior in quality to that given to the cows on the winter rations B and C. This inferiority is shown by a much lower protein, lime and phosphate and a much higher crude fibre content. Not only was the number 1 pasture of inferior quality, but it was evident from inspection in May and the beginning of June that it was far more limited in quantity than was the case with number 2 pasture in mid April. These different feeding conditions at the beginning of summer grazing had a distinct effect on the yield of milk and fat as seen in Table III (see opposite page).

From Table III we can conclude that as a result of changing from the good winter ration A to the poor pasture No. 1 there was a drop in the amount of milk secreted, and a distinct diminution in the yield of fat. The transition from the balanced ration B to the good pasture (No. 2) had no effect on the average flow of milk, but it invariably resulted in diminishing the yield of fat. In the case of the cows on the low protein ration C, on being turned to the same pasture (No. 2) there was an increase in the yield of milk. While there was an increased yield of fat from Moira and Seren, the fat secretion from Berriers diminished. The net result was that the average fat secretion of this group kept constant as a result of grazing.

TABLE III.

The effect of 1928 summer grazing on the percentage fat and on the total fortnightly yield of milk and fat.

Group 1. Cows on Winter Ration A and turned to pasture No. 1.

	% Fat.		*Yield of milk* (lbs.)		*Yield of fat* (lbs.)	
Cow.	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*
Gweneira ...	3.70	3.60	298	293	11.03	10.54
Seren ...	2.80	2.00	325	276	10.00	5.52
Betty ...	3.40	3.20	283	275	9.72	8.80
Catti ...	3.30	2.50	362	331	10.98	8.28
Average ...	3.30	2.82	317	294	10.43	8.28

Group 2. Cows on Winter Ration B and turned to pasture No. 2.

	% Fat.		*Yield of milk* (lbs.)		*Yield of fat* (lbs.)	
Cow.	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*
Gwen 2 ...	3.35	2.93	363	350	12.16	10.25
Jean ...	3.20	3.10	611	589	19.55	18.26
Nancy 3 ...	2.90	2.40	386	417	11.19	10.01
Average ...	3.15	2.81	453	452	14.30	12.84

Group 3. Cows on Winter Ration C and turned to posture No. 2.

	% Fat.		*Yield of milk* (lbs.)		*Yield of fat* (lbs.)	
Cow.	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*	*Before grazing.*	*After grazing.*
Berriers ...	3.22	2.58	402	440	12.94	11.35
Moira ...	3.13	3.10	280	298	8.76	9.24
Seren 2 ...	3.20	3.08	329	363	10.53	12.18
Average ...	3.18	2.92	337	367	10.74	10.92

These results are of special interest in view of the attention which has recently been devoted to the question of early summer grass. They emphasise the fact that under favourable conditions the pasture at this time of the year has an exceptionally high feeding value and reaches the level of a concentrated feeding stuff. At the same time it is shown that pastures are liable to fluctuate widely according to their environment. These fluctuations are so great that under a combination of adverse circumstances such as shallow soil, exposed situation and prolonged drought, the feeding value of the grass is no better than that of hay. This low quality is unfortunately associated with poor growth, and the supply of nutrients may be restricted to such an extent as to influence adversely both the condition of the animal and the secretion of the fat.

It is further shown that the yield of fat in the milk when cows are turned out of doors is not of necessity maintained even if turned to a pasture exceptionally rich in nutritive matter. In 1926 and 1927 the secretion of fat was more than maintained after a fortnight's grazing in a field of good medium pasture containing an average of 15 per cent. crude protein, 23 per cent. crude fibre and 5.9 per cent. silica free ash. In 1928 the cows were turned out to a different field three weeks earlier than in previous seasons. As indicated in Table III, group 2, the yield of fat was actually diminished in the case of animals previously fed on a balanced winter ration. This occurred in spite of the fact that the pasture showed a higher concentration of total nutrients than that of previous years. (See Table II, pasture No. 2.) There is a possibility that some quality of the pasture not shown by chemical analysis may be of importance in affecting the nutritive value of young luscious grass for milk production in mid April and May. It may be of interest to point out, however, that as shown in Table IV, there is a greater difference between the true and crude protein of the pasture in 1928 than in previous years.

TABLE IV.

Year.	*1926.*	*1927.*	*1928.*
Field.	*Cae'r Efail.*	*Cae'r Efail.*	*Cae Mawr*
Crude protein ...	16.19	13.84	23.06
True protein ...	13.36	12.18	17.37
Difference ...	2.83	1.66	5.69

Effect of grazing on casein and inorganic phosphate.

On this occasion the opportunity was taken of finding the effect on these constituents when the change over to grass resulted in a diminished fat yield. The results given by the three different groups are shown in Table V (see opposite page).

It is seen from Table V that the milk of all the individual cows included in this experiment contained a low concentration of casein. A mean casein content of 2.01 was obtained before grazing compared with 2.33 in the case of cows sampled at the end of the winter feeding of 1927. It should be indicated that this low casein content was reflected in a low total protein content, only 2.69 being present compared with 3.04 in the spring of 1927.

TABLE V.

The effect of the 1928 summer grazing on the casein and inorganic phosphate of milk.

Group 1. Cows on Winter Ration A and turned to pasture No. 1.

Cow.	% Casein. Before grazing.	% Casein. After grazing.	Change in Casein.	% Inorg. P_2O_5 before grazing.	% Inorg. P_2O_5 after grazing.	Change in Inorg. P_2O_5
Gweneira ...	1.96	2.04	+ .08	.1740	.1740	.0000
Seren ...	2.16	2.16	.00	.1491	.1550	+ .0059
Betty ...	1.88	1.81	— .07	.1600	.1580	— .0020
Catti ...	2.05	2.10	+ .05	.1615	.1617	+ .0002
Average ...			+ .015			+ .001

Group 2. Cows on Winter Ration B and turned to pasture No. 2.

Cow.	% Casein. Before grazing.	% Casein. After grazing.	Change in Casein.	% Inorg. P_2O_5 before grazing.	% Inorg. P_2O_5 after grazing.	Change in Inorg. P_2O_5
Gwen 2 ...	2.06	2.10	+ .04	.2130	.2105	— .0025
Jean ...	2.24	2.20	— .04	.1527	.1585	+ .0058
Nancy 3 ...	2.01	2.08	+ .06	.1500	.1620	+ .0120
Average ...			+ .020			+ .005

Group 3. Cows on Winter Ration C and turned to posture No. 2.

Cow.	% Casein. Before grazing.	% Casein. After grazing.	Change in Casein.	% Inorg. P_2O_5 before grazing.	% Inorg. P_2O_5 after grazing.	Change in Inorg. P_2O_5
Berriers ...	2.08	2.28	+ .20	.1588	.1660	+ .0072
Moira ...	1.92	2.22	+ .30	.1740	.1791	+ .0051
Seren 2 ...	2.04	2.19	+ .15	.1393	.1635	+ .0242
Average ...			+ .22			+ .0122

The cows in group 1 of Table V represent those animals where the change over to grass had the most adverse effect on the yield of fat. It is seen that the change did not affect the concentration of either the casein or the inorganic phosphates.

The cows in group 2 include the animals on the balanced ration turned out to the superior pasture No. 2. Table III shows that with these cows the turning out to grass depressed the fat yield, and the results for the change in casein and inorganic phosphate are materially the same as in group 1. The casein has remained remarkably constant, and the changes in the inorganic phosphate are very small.

The cows in group 3 were on the low protein ration before being turned out to grass—a ration lower in digestible protein and total phosphate than the other two winter feeds. Here it is seen that the change in inorganic phosphate is greater than that which occurred in either of the other groups. In marked contrast to the other groups there has also been an appreciable increase in the concentration of casein.

Summary and Conclusion.

It is fully realised that in an experiment of this kind there is inevitably the interplay of many factors, the most important of these being the idiosyncracies of the individual animal. While a considerable number of animals have been dealt with since the summer of 1926, it is considered that a larger number must be included before a detailed interpretation of the results can be attempted. Thus it is considered premature to attempt any definition of the relationship which exists between the change in total amount of fat secretion and the change in the phosphorus containing compounds at the commencement of summer grazing. The results already obtained during the last three seasons clearly indicate, however, that there is a connection between these two changes, seeing that generally

(*a*) An increase in fat secretion is accompanied by a rise in concentration of the phosphorus compounds.

(*b*) When the fat secretion is lowered there is no change in the concentration of these compounds.

The effect produced by grazing on fat secretion, casein concentration and inorganic phosphate evidently depends on the feeding of the animals indoors, prior to going out to grass, and also on the nutritive value of the grass. When the cows are on a high level of nutrition immediately before grass and are turned to a sparse pasture of poor quality there is a diminution in fat secretion, while the concentration of casein and inorganic phosphate remain constant. When, on the other hand, the animals are on a low level of nutrition before grazing, and are given enough pasture of good quality, an increase in fat secretion takes place, accompanied by a rise in casein and inorganic phosphate concentration.

Acknowledgement.

The writers wish gratefully to acknowledge their indebtedness for all particulars in connection with the rations used at the different farms, and for the full sampling facilities which were provided.

SOME STUDIES IN PASTURE ESTABLISHMENT.

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and

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The following observations are made from analyses of a number of experiments put down at Bangor in the years 1925 and 1926. The plots, which were examined in detail in the early spring of 1928, form part of a more comprehensive scheme undertaken by the Bangor Regional Conference, and is added to from year to year. They follow as developments from earlier schemes, reported upon from time to time from the Agricultural Department at Bangor, or published in earlier volumes of this Journal.

It should be noted that they are in their narrower sense mainly designed to meet the requirements of farmers in North Wales, where land normally remains under grass from four to seven years, being down to hay for the first year or two and then grazed. In addition they have usually to carry a heavy winter stock—usually sheep, are not cleared as early in spring as one would wish them cleared, and are subject to heavy and continuous winter rains.

It should also be added that some of the trials, *e.g.* (1) Welsh Experimental Mixture, have a wider reference in that they instance schemes designed by the Welsh Agricultural Education Conference to be tested throughout Wales.

The percentage analysis of the growth on the plots in March, 1928, when the ground lay very bare after heavy winter grazing reveal some interesting facts.

The unsown miscellaneous elements, which can all be regarded as weeds, figure very highly throughout, and are remarkably even on plots 1, 2, and 4, constituting about 45 per cent. of the whole vegetation. On plot 3, as one would expect, they are considerably higher, being close on 60 per cent. The moss flora, which is a passing winter phase of the vegetation, shows little variation, but is highest on plots 2 and 3 where the wild white clover element is least prosperous. The proportion of bent grass—the most menacing weed to young leys in North Wales, with high rainfall and open soil textures, is high throughout. It is, however, considerably more pronounced on plots 3 and 4. On plot 1 it is presumably checked by a good percentage of perennial ryegrass, while on plot 2 the check to its growth is due to the high percentage of crested dogstail. This again bears out former observations, that though crested dogstail may be rightly regarded as a second rate pasture element on the best land, it is worthy of inclusion on the lighter soils of North Wales in that it proves a very effective check on bent grass.

The other species contributing to the miscellaneous unsown flora are evenly represented over all the plots and do not call for any observation.

(1) WELSH EXPERIMENTAL MIXTURES.

Cae Bryn Gwylan Pellaf, College Farm, Bangor.

Sown April, 1925. Examined March, 1928.

	Plot 1.			*Plot 2.*			*Plot 3.*			*Plot 4.*		
	Seed sown per acre. lb.	*Percentage composition.*		*Seed sown per acre.* lb.	*Percentage composition.*		*Seed sown per acre.* lb.	*Percentage composition.*		*Seed sown per acre.* lb.	*Percentage composition.*	
SOWN.												
Italian ryegrass ...	...	...		2	...		7	...		5	Trace	
Perennial ryegrass ...	14	20.6		4¾	6.9		18	18.4		10	8.5	
Cocksfoot ...	6	6.4		2½	8.1		2	3.2		6	5.0	
Timothy ...	3	6.7		¾	1.2		2	3.8		3	4.9	
Meadow foxtail ...	...	.1		2½	1.5		...	Trace		...	.2	
Meadow fescue ...	...	...		4	.7		...	Trace		...	Trace	
Rough stalked meadow grass ...	...	1.5		¼	4.0		...	2.0		½	5.8	
Smooth stalked meadow grass ...	...	...		¼	.1		...	...		...	Trace	
Crested dogstail ...	...	2.1		¾	22.2		...	2.6		½	14.2	
Hard fescue ...	...	.1		1	.2		...	.1		...	Trace	
Tall oat grass ...	...	...		4	.3		...	...		...	...	
Yellow oat grass ...	...	...		½	.1		...	Trace		...	Trace	
Sweet vernal grass ...	...	.2		1	.3		...	...		...	Trace	
English broad red clover	2	...		4	...		4	...		2	...	
Late flowering red clover	1½	.1		...	.2		...	.3		3	.2	
Alsike ...	1	...		1¼	.3		1	...		...	...	
White clover (Dutch) ...	...	...		1¼	...		1	...		...	...	
Kidney vetch ...	...	...		2½	...		...	...		...	...	
Trefoil ...	...	...		1½	...		2	...		...	...	
Yarrow ...	...	...		¼	1.8		...	...		...	...	
Chicory ...	...	...		2	...		...	...		...	...	
Wild white clover ...	¾	19.8		..	12.1		...	11.4		½	16.5	
UNSOWN.												
Bent grass ...		11.4	43.1		11.4	45.9		20.8	58.1		18.3	44.9
Mosses ...		24.6			28.2			30.3			23.1	
Miscellaneous species ...		7.1			6.3			7.0			3.5	

Plot 1. General standard mixture.
Plot 2. Welsh experimental standard mixture.
Plot 3. Simple mixture based on local practice.
Plot 4. " Ideal " mixture.
The plots were each ¼ acre in size.

The sown species after an interval of three years constitute on plots 1, 2, and 4 alike some 55 per cent. of the total population. On plot 1 most of this is perennial ryegrass and wild white clover, on plot 2 crested dogstail and wild white clover, while on plot 4 the three species mentioned together with rough stalked meadow grass contribute to it. It is surprising to find wild white clover establishing itself so well where it was not sown on plots 2 and 3. Presumably on plot 2 it displaced the fugitive Dutch clover sown thereon, and their various occupation of the ground seems to have been an effective check to bent grass, for we note that it figures far less on plot 2 than on plot 3, where the natural colonisation of wild white clover was a slow progression over bottom space unoccupied at the start.

Plot 1 amply demonstrates the fact that a successful seeds mixture loses nothing in efficacy by being a simple blend of a few of the species that suit the purpose in view. The reverse of this is equally evident from plot 2. The blending of a mixture of a multiplicity of species, here a score or more, all in small quantities, has nothing to commend it to the farmer. Had crested dogstail been omitted at the start and had conditions not favoured its spread in the meantime together with the spread of unsown wild white clover the prospect of this plot would have been a desolate one indeed. As it stands it is a clear indictment of the comprehensive multiple mixture at least for such exacting conditions as are experienced on North Wales farms with our rigorous climate, and exacting grazing conditions.

The mixture on plot 3 has given the poorest cover from the botanical standpoint. The initial seeding of perennial ryegrass was much higher than on plot 1, yet the representation of this species in the pasture after three seasons compares very unfavourably with that of the same grass on plot 1. This bears out afresh our earlier findings that this grass thrives best in combination with wild white clover. The figures here also bear out our earlier observations that a high initial seeding of Italian ryegrass, which only figures in the first year of the ley, tends to depress the representation of the truly permanent elements, perennial ryegrass, throughout the later and established phases of the ley.

The representation of cocksfoot is always low in a winter analysis by weight of pastures. It is grazed very hard and scarcely gets its full due credit from the figures.

On plot 4 the light seedings of rough stalked meadow grass and crested dogstail have established these plants sufficiently to seriously affect and depress the growth of perennial ryegrass.

Of all the plots the growth here is the most varied in that most of the sown species figure in the pasture established from seed.

Timothy figures but slightly in the pasture when three year old. The plant is a poor colonist, and though in our climate it persists well under mowing conditions, an occasional season of grazing and the consistent heavy winter grazing tend alike to depress it.

Rough stalked meadow grass establishes itself pro rata with the heaviness of the initial seeding, and, besides, it is possessed of considerable colonising power, establishing itself where not sown.

Similarly the rate of seeding of wild white clover, within the limits of initial seedings here given, governs the take of the plants up to the third year. Beside, where not sown, indigenous forms of the plant have succeeded in establishing themselves to a marked extent by the third year.

In conclusion, it would seem that the wild white clover status of these plots holds the key position to the balance of the other species within them, and in the light of this fact the importance of adequate initial seedings of this plant should again be stressed.

(2) UPLAND GRASS SEEDS TRIALS.

Cae Stesion, College Farm, Bangor, and Taldrwst, Llanfairynghornwy, Anglesey. Sown 1926; Examined 1928.

The object of these trials was to test the influence of seeding of excess of one of a number of varieties commonly sown in a mixture (to the exclusion of others) with a sowing of a blend of those species. There were four plots, each ¼ acre in size.

The three varieties were cocksfoot, timothy, and wild perennial ryegrass. These were included along with other elements which were common throughout all the plots as follows :—

	Seed per acre in lbs.			
	Plots.			
	1	2	3	4
Italian ryegrass	3	3	3	3
Rough stalked meadow grass	2	2	2	2
Montgomeryshire late flowering red clover ...	6	6	6	6
Wild white clover	1	1	1	1
Cocksfoot	12	...	...	4
Timothy	...	12	...	4
Wild perennial ryegrass	...	...	27	9

It will be noticed that plot 1 received excess of cocksfoot but no timothy or wild perennial ryegrass. Plot 2 received excess of timothy but no cocksfoot or wild perennial ryegrass, while on plot 3 excess of wild perennial ryegrass is noticed to the exclusion of cocksfoot and timothy. Plot 4 received an even blend of all the three grasses sown singly on the other plots.

Though the two centres examined, at the College Farm, Bangor, and at Taldrwst, Llanfairynghornwy, Anglesey, do not stand on high ground yet they conform to the upland designation of the experiment in that they each carry a very heavy complement of sheep and the pastures in each have to stand very heavy winter and early spring grazing.

Percentage Composition of the Pastures by Weight.

	March, 1928. *College Farm.*				*April,* 1928. *Taldrwst.*			
	Plots.				*Plots.*			
	1	2	3	4	1	2	3	4
Sown.								
Italian ryegrass ...	2.6	1.4	.7	1.1	.1	.9	.3	.6
Perennial ryegrass ...	2.1	3.9	48.2	18.4	1.4	2.2	27.8	21.3
Cocksfoot ...	49.3	.4	.6	12.8	27.5	...	...	6.7
Timothy ...	...	32.2	...	16.5	...	18.5	...	5.3
Rough stalked meadow grass ...	14.2	10.3	11.0	16.2	23.6	34.7	26.6	20.8
Red clover ...	5.4	5.6	5.1	2.7	.6	.9	Trace	...
Wild white clover ...	7.5	15.0	12.6	15.5	7.1	12.7	8.5	4.4
Unsown.								
Crested dogstail ...	.4	.4	.4	1.5	...	...	...	...
Annual meadow grass ...	.9	2.2	1.9	.2	7.0	4.3	6.6	3.5
Bent grasses ...	9.8	17.2	10.2	5.8	13.0	3.2	10.9	14.8
Yorkshire fog ...	2.3	4.8	2.5	3.9	.4	.1	Trace	1.2
Daisies ...	.3	.2	1.7	.5	1.9	3.2	1.7	.3
Buttercups ...	1.0	.7	.1	.2	...	...	...	...
Mosses ...	4.0	4.0	3.8	4.3	15.3	15.1	14.8	19.6
Other miscellaneous unsown weeds ...	.3	1.6	1.1	.5	2.0	2.3	2.7	1.7

The fields have been mown for hay at both centres in 1927.

Species sown in excess.

At the College Farm the species sown in excess, cocksfoot, timothy, and wild perennial ryegrass, constitute approximately one half, one third, and one half respectively of the pasture established by the end of the second winter, while at Taldrwst the representation at that time stands respectively at a quarter, a fifth, and a quarter.

On plot 4 the joint contribution of these species stands at a half of the total growth established at the College Farm, and a third at Taldrwst.

The superiority of establishment of these three species at the College Farm is accompanied by a much smaller moss flora (8-4 per cent.) compared with 15-19 per cent. of this element at Taldrwst. Besides, it will be noticed that at Taldrwst conditions must have favoured rough stalked meadow grass to a remarkable degree. Two pounds per acre of the seed of this grass were sown on all the plots alike, and at Taldrwst it ranged from 20 to 85 per cent. on the plots.

At the College Farm.

None of the three species seems as yet to have been able to establish itself where not sown. Timothy seems peculiarly bound to the limits of the sown area, perennial ryegrass excels cocksfoot, but the quantities of either self-established are quite insignificant. Excess seeding of both cocksfoot and wild perennial ryegrass has succeeded in firmly establishing the respective plants. The establishment of cocksfoot on plot 1, however, seems to have checked the establishment of wild white clover more than the establishment of wild perennial ryegrass did on plot 3. Further, it has slightly favoured the spread of rough stalked meadow grass. The take of timothy, sown in excess on plot 2, has been less satisfactory. The fact of this plant being more of a top grass and not filling the sole of the pasture, is reflected in the increased representation of wild white clover and bent grass on this plot. The unoccupied ground space has been colonised by the natural weed, bent grass, which stands here at 17 per cent, compared with 10 per cent. or less elsewhere. Likewise the weed Yorkshire fog, though not significantly represented here, is of twice its bulk on the other plots. On plot 4 where the three species compete in a blend, timothy seems to have been the least affected by competition, while cocksfoot has shrunk the most, with wild perennial ryegrass intermediate. The joint growth contribution of the blend gives a satisfactory 46 per cent. of total growth, which, coupled with a higher accompaniment of wild white clover and a *much lower figure for bent grass than is found on the other plots, seems to single out the blend as leading to the most satisfactory* establishment.

At Taldrwst.

The lower proportion of the varying sown species, the higher proportion of rough stalked meadow grass and the denser moss population at this centre compared with the College Farm has already been noted. It is significant that here also on their respective plots cocksfoot and wild perennial ryegrass are identical in their contribution, viz., 28 per cent., while the proportion of timothy where it was sown bears to the other species the same ratio (18 per cent.) as it did at the College Farm. In other words, timothy on plot 2 bears at both centres, compared to cocksfoot on plot 1 and wild perennial ryegrass on plot 8, the same ratio of two to three.

At Taldrwst, however, the joint contribution to growth of the blend of the three species on plot 4 differs from the College Farm in being considerably superior to any of the other plots. This is contributed to not by the thriving of all three species alike but by the sole excellence of the ryegrass element. The representation of cocksfoot and of timothy on plot 4 is very small, whereas wild perennial ryegrass has only been slightly depressed as compared with its representation where it was sown alone. The competition within the plot does not seem to have adversely affected the ryegrass here, whilst it has seriously crippled the take of cocksfoot and of timothy.

Here timothy and cocksfoot seem alike peculiarly plot bound. No trace of either was found where not initially sown. As at the College Farm, the take of cocksfoot on plot 1 seems to have adversely affected the spread of wild white clover, and to have favoured the spread of annual meadow grass and of bent grass, which facts alike operate to the detriment of the sward. Similarly with the College Farm, the less efficient take of timothy on plot 2 has favoured the spread of wild white clover. But whereas at the College Farm it tended further to favour an increase in the weed element bent grass, this is not the case here; the much more desirable element, rough stalked meadow grass, has been the ready aggressor, and it has, by itself advancing to 85 per cent., retarded and checked bent grass to a very subordinate position, 5 per cent.

Substituting wild perennial ryegrass in plot 8 for cocksfoot in plot 1, we find that the representation of species is almost identical on the two plots, with the one qualification that the rough stalked meadow grass element is a little higher and the bent grass element a little lower on the ryegrass plot than on plot 1 with cocksfoot.

On plot 4, where the joint contribution of the blend has enhanced their joint representation, due mostly to the good take of ryegrass already noted, the rest of the flora has been definitely affected. The proportions of the undesirable moss and bent grass elements have been augmented, while the proportions of rough stalked meadow grass and wild white clover have been depressed, and the latter considerably so.

Whether these undesirable effects are more than balanced by the excellence of the ryegrass take is open to question. It is not easy to say which plot at Taldrwst is the most satisfactory; and whereas at the College Farm one seems justified in regarding plot 4 as the most promising at the time of the analyses, at both centres alike the real merits of the various plots can only be determined by analyses at some future date when the leys will have passed through critical stages which have yet to come.

(3) TESTS OF WHITE CLOVERS.

Cae Stesion, College Farm, Bangor.

Sown April, 1926, Examined March, 1928.

Four plots, each ¼ acre in size, were put down with oats in 1926 to test the relative values of different small leguminous species. The basal mixture, which was the same throughout, was as follows :—

Italian Ryegrass	4 lb. per acre.
Perennial ryegrass	12 lb. per acre.
Cocksfoot	6 lb. per acre.
Timothy	2 lb. per acre.
Rough stalked meadow grass	1 lb. per acre.
Montgomeryshire late flowering red clover ...	6 lb. per acre.
Tall oat grass	2 lb. per acre.

In addition

Plot 1 received 1 lb. per acre Sutton's wild white clover.
Plot 2 received 1 lb. 4 oz. per acre Sutton's white Dutch clover.
Plot 3 received 1 lb. 4 oz. Sutton's New Zealand wild white clover.
Plot 4 received 3 lb. per acre Sutton's genuine wild trefoil.

The plots were mown for hay in 1927, and they were examined in bare condition in March, 1928.

Percentage composition of the pastures by weight, March, 1928.

	Plot 1.	*Plot 2.*	*Plot 3.*	*Plot 4.*
	Wild white clover.	*Dutch white clover.*	*New Zealand wild white clover.*	*Genuine wild trefoil.*
SOWN.				
Italian ryegrass ...	.5	.6	.9	.4
Perennial ryegrass ...	23.7	19.0	23.8	19.8
Cocksfoot ...	14.4	9.4	11.8	11.7
Timothy ...	9.6	6.0	10.0	4.6
Rough stalked meadow grass ...	16.2	17.3	13.0	13.1
Tall oat grass ...	.3	.4	.8	.5
Red clover ...	5.0	6.2	8.5	4.4
White clover ...	10.3	7.0	7.6	6.1
Trefoil ...	...	...	...	...
UNSOWN.				
Crested dogstail ...	.1	1.5	1.3	.2
Annual meadow grass ...	6.7	6.7	4.9	5.1
Bent grass ...	5.7	18.9	7.8	20.4
Yorkshire fog ...	1.1	3.1	1.9	2.1
Mosses ...	5.5	2.6	6.4	8.0
Other miscellaneous species ...	.9	1.2	1.3	3.5

The excess of miscellaneous unsown species in plot 4 are mostly made up of daisies, buttercups, and pearlworts.

It should be noted that white clover is a crop that figures very little in the winter herbage. In spring the plant sends out fresh stolons which creep along the ground horizontally, and send up from these the well known trifoliate leaves on long stalks, together with the flowers. As winter sets in these die down, and most that one finds in winter is a small rosette of growth at the top of the main roots. As the crop lies quiescent in winter, a fugitive winter growth of moss often comes as a passing phase of the pasture, especially with the presence of surface moisture such as is characteristic of our country.

The figures for white clover alone in these various plots in March of the second year would seem to tell us but little. Ten per cent. of this plant on plot 1 with a seeding of one pound per acre of wild white clover, and 7 per cent. with 20 oz. of New Zealand wild white clover against 7 per cent. and 6 per cent. where Dutch white and wild trefoil were sown respectively and no wild white included at all would seem to discount altogether the belief that wild white clover possesses any merit above other small leguminous plants.

If self establishment can give us in two years' time a representation of wild white clover plants as near to that obtained by a comparative heavy and expensive initial seeding we might be led to ask why concern ourselves about including wild white clover in the seeds list at all. This conclusion is, however, quite unwarranted, and has to be seriously qualified.

A glance at the figures for bent grass, the biggest menace to the correct establishment of pastures on the lighter lands in wet climates, will show us that whilst this plant flourishes to the extent of 19 per cent. and 20 per cent. respectively on the plots where no wild white clover was sown, it is present only to the extent of 6 and 8 per cent. on the plots where native wild white clover and New Zealand wild white clover respectively were sown.

Similarly it will be noted that the stronger growing excellent sown species, such as perennial ryegrass, cocksfoot and timothy, have thriven best in association with wild white clover. As has previously been noted elsewhere in the course of this article, rough stalked meadow grass, being a bottom grass, is itself in direct competition with wild white clover for colonisation of the same layer of herbage space.

The wild trefoil on plot 4 had all died out before the end of the second year of the ley, but the relative poverty of species represented on the plot shows that though self-established wild white clover may eventually come in and amend its population, the lack of a strong growth of leguminous bottom herbage in the earlier stages of the ley has seriously marred its quality up to this point.

The differences in the other pasture ingredients from plot to plot are of too low an order for any definite conclusion to be drawn from them.

The test has, however, definitely established once more the fact that, even from a winter analysis where pasture differences are obscured and smoothed down to the stage where they are least obvious, the excellence of a pasture is very largely governed by the degree of establishment of wild white clover in the earlier stages of the formation of that pasture. It demonstrates further that the sowing of Dutch white clover which is not permanent, in the hope that meantime wild white clover will of itself become sufficiently established to supplement and to replace it as it dies out, falls far short of what can be accomplished with an initial seeding of wild white clover.

NATIONALITY AND STRAIN TEST OF GRASSES

(WITH OBSERVATIONS ON PASTURE ANALYSES METHODS).

By R. Alun Roberts, Ph.D., B.Sc.,

and

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In April, 1925, plots were laid down in Cae Bryn Gwylan Pellaf at the College Farm, Bangor, to test the value of some grasses of different strains and nationalities which were then offered to the farming community, in competition in seeds mixtures in the field and under hard grazing conditions.

The field had been ploughed from a six years' ley in 1923, and cropped with oats in that year. In view of the distance of the field from the farm buildings a crop of temporary hay was taken on the north half of the field instead of roots in 1924. This was consumed by heifers wintered out in 1924-25, and the field seeded down in 1925 with Record oats as a nurse crop, receiving 6 cwt. of Basic Slag per acre.

There were in all twenty-four plots, each one land width (16 ft.) and varying in lengths from 86 yds. to 58 yds. There were in all twelve control plots, a control alternating throughout with an experimental plot that contained but one variant. The following table gives the seeding for the control plots and the basal seeding for the experimental plots :—

TABLE I.

	lb. per acre.	
Italian ryegrass	4	Sutton's.
Perennial ryegrass	12	McGill and Smith ordinary Ayrshire.
Cocksfoot	6	Garton's Danish.
Timothy	5	Garton's U.S.A.
Meadow fescue	5	Garton's U.S.A.
Rough stalked meadow grass ...	½	Sutton's.
Crested dogstail	½	Sutton's.
Late flowering red clover	3	Sutton's.
Wild white clover	1	Sutton's.

It will be seen that fair seedings of perennial ryegrass, cocksfoot, timothy and meadow fescue were given. These were the elements varied from plot to plot, and we felt that a fair initial seeding was necessary in order to give the grass concerned a fair chance of establishment. The elements which were constant throughout the plots, viz., rough stalked meadow grass, dogstail, red clover, were present only in small quantities, so as not to challenge the spread of the variable members with whose behaviour we were mostly concerned. A fair seeding of wild white clover was given, because we felt that whatever relative merits these varying strains of grasses might possess, those merits should be estimated where grown along with a fair representation of wild white clover.

The odd-numbered plots, 1, 3, etc. to 23, were all controls; on the even-numbered plots there was substituted a grass of a strain or nationality different from the corresponding commercial strain present in the control. Each plot contained but one variant from the controls thus :—

Plot 2. Sutton's indigenous perennial ryegrass.
Plot 4. Garton's indigenous perennial ryegrass.
Plot 6. McGill & Smith's indigenous perennial ryegrass.
Plot 8. Svalof Victoria perennial ryegrass.
Plot 10. Garton's mowing English cocksfoot.
Plot 12. Garton's grazing New Zealand cocksfoot.
Plot 14. Sutton's indigenous cocksfoot.
Plot 16. McGill & Smith's wild New Zealand grazing cocksfoot.
Plot 18. McGill & Smith's mowing Scotland cocksfoot.
Plot 20. Sutton's American mowing timothy.
Plot 22. Sutton's Scotland grazing timothy.
Plot 24. Garton's English grazing meadow fescue.

TABLE II.

Percentage Composition by Weight.

	Plot 2	Plot 3	Plot 4	Plot 6	Plot 8	Plot 10	Plot 11	Plot 12	Plot 14	Plot 16	Plot 18	Plot 19	Plot 20	Plot 22	Plot 24
	Sutton's indigenous per. ryegrass.	*Control.*	*Garton's indigenous per. ryegrass.*	*McGill & Smith's indig. ryegrass.*	*Svalof Victoria ryegrass.*	*Garton's English cocksfoot.*	*Control.*	*Garton's grazing N.Z. cocksfoot.*	*Sutton's indig. cocksfoot.*	*McGill & Smith's N.Z. cocksfoot.*	*McGill & Smith's Scottish cocksfoot.*	*Control.*	*Sutton's American timothy.*	*Sutton's Scot. grazing timothy.*	*Garton's English graz. meadow fescue.*
SOWN AND VARIABLE.															
Perennial ryegrass ...	**23.1**	13.5	**26.7**	**14.2**	**7.2**	8.3	10.9	8.4	11.8	9.8	9.4	11.3	9.7	13.2	9.8
Cocksfoot ...	2.3	1.9	1.2	1.5	1.8	**3.5**	2.5	**14.7**	**12.5**	**16.1**	**6.2**	2.5	2.3	3.0	3.1
Timothy ...	1.7	4.9	2.8	4.0	3.2	2.1	2.9	5.6	4.7	4.1	4.4	4.4	**4.6**	**5.8**	3.9
Meadow fescue ...	.2	.1	.1	Trace	...	.7	.3	.4	.5	Trace	.6	.4	.2	.5	**.5**
SOWN AND COMMON TO ALL.															
Italian ryegrass ...	...	Trace	...	...	...	...	...	...	...	...	...	...	...	...	...
Rough stalked meadow grass	8.9	7.7	7.4	4.8	3.9	3.7	6.9	6.0	6.1	4.5	7.6	6.3	5.5	5.4	6.5
Crested dogstail ...	13.9	7.8	10.6	13.7	9.6	11.6	15.0	14.6	10.8	10.3	12.3	10.6	10.3	15.9	9.8
Red clover ...	...	.1	.1	...	.1	...	...	.2	.3	...	.1	.6	.2	.4	...
Wild white clover ...	26.1	28.5	24.0	20.0	25.4	19.5	17.7	14.2	16.3	10.8	14.2	18.2	20.0	11.4	18.9
MISCELLANEOUS UNSOWN.															
Bent grass ...	4.6	3.9	1.9	3.1	7.2	5.1	4.1	6.0	6.1	8.4	9.8	7.8	6.9	6.0	8.3
Yorkshire fog ...	3.7	3.2	.8	1.4	4.4	7.1	5.8	4.8	4.3	6.1	5.8	6.4	1.9	2.2	1.7
Mosses ...	6.1	15.8	12.1	21.5	23.3	24.9	13.5	13.5	14.4	19.0	19.0	16.3	27.3	25.0	30.3
Other miscellaneous species	9.6	12.5	12.3	15.9	13.7	13.5	20.6	11.6	12.2	10.6	10.6	15.2	11.5	11.5	7.1
Supplementary Table. Percentage Composition by Percentage Frequency Method (Tiller Unit).															
SOWN VARIABLES ALONE AS ABOVE.															
Perennial ryegrass	**23.6**	18.5	**40.0**	**21.7**	**10.9**	12.2	13.2	13.1	16.0	11.8	11.9	13.5	14.2	17.7	14.1
Cocksfoot ...	.9	1.1	.6	1.0	1.0	**1.5**	1.0	**5.9**	**6.0**	**6.8**	**2.0**	1.1	1.2	1.2	1.1
Timothy ...	1.2	3.5	2.7	8.1	2.7	1.5	1.7	8.1	2.7	2.8	2.5	2.7	**3.3**	**3.0**	8.0
Meadow fescue ...	.4	.1	.2	.1	...	.4	.2	.2	.5	.1	.5	.4	.2	.5	**.6**

The figures for the varying strains of each species are shown in bold figures in the table.

In each case these were substituted at the same rate of seeding as the commercial form they each displaced from the control.

The land was mown for hay in 1926 and 1927. The plots were botanically examined in April of 1928 and the percentage by weight of the main ingredients are included in the table below. The analysis from three control plots only are included here, selected at various points through the series, viz., Plots 8, 11, and 19.

It will be seen that percentage figures of analysis for the variable elements, perennial ryegrass, cocksfoot, timothy, and meadow fescue, which we are here mostly concerned with, have been twice inserted in the foregoing table.

In the top part of the table the percentage of each species is calculated from the total dry weight of all plants of that species present in the bulk sample. There is another method of analysis practised, wherein the number of plants of each species found in the samples, after a unit count, forms the basis of their percentage representation. The supplementary table gives the figures for these four grass species calculated by this " percentage frequency " method.

It is interesting to note that the two methods are in close agreement, and though the percentage figures are not identical for any species, the relative positions of the species are the same in both tables.

This is of prime importance, for what a test such as this seeks to find is not the absolute representation of any one species on any plot at any point of time, but rather the relative success of take of the different species given equal chances and the same treatment from the start.

Consideration of Results.

The figures for establishment given here variously by weight and by number of plant units are singularly interesting. The farmer is more directly concerned with the bulk of growth above ground, and as when the ground is grazed bare we are reckoning really but what stock have left behind them, the representation of a palatable species is liable to be underestimated. The less palatable elements are not likely to be so well grazed and may accordingly figure unduly highly in the percentage by weight table.

On the other hand, by the percentage frequency method, a unit is a unit, but it varies from species to species and it is often of necessity arbitrarily defined. For instance, a unit of cocksfoot may in bulk of fodder contribute many times the quantity contained in a unit of fine-leaved fescue, yet each counts as a unit. However, as a basis for assessing the success of establishment, and without reference to bulk of yield (a consideration here largely negatived by the bareness of the pasture when analysed) the method has much to commend it. Further, in comparing various strains within the one species the unit or tiller varies but very little in size.

Examining the establishment figures for these strains and nationalities as illustrated by the tables where the one method is complementary to the other we find significant and interesting differences between them.

Perennial ryegrass strains.

TABLE III.

	Total tillers in sample.	*Per cent. by weight.*	*Per cent.* by tiller unit.*
Sutton's indigenous perennial ryegrass ...	219	23.1	23.6
Garton's indigenous perennial ryegrass ...	735	26.7	40.0
McGill & Smith's indigenous perennial ryegrass ...	426	14.2	21.7
Svalof " Victoria " ryegrass ...	199	7.2	10.9

The ryegrass element on the control plots, ordinary commercial Ayrshire, averages 12 per cent. by weight or 15 per cent. by tiller unit. The three indigenous strains each excel it, but to varying extents. The leading strain Garton's indigenous, forms 26.7 per cent. by weight, and 40 per cent. by tiller unit, followed by Sutton's indigenous strain, 23.1 per cent. by weight and 23.6 per cent. by tiller unit. McGill & Smith's indigenous strain proves less successful, being present to the extent of 14.2 per cent. and 21.7 per cent. by weight and tiller unit respectively.

It is seen that the figures in the two columns of the foregoing sub-table in some instances approach closely to each other, e.g., Sutton's indigenous, 23.1 to 23.6 per cent., while in others they are more divergent, e.g., Garton's indigenous, 26.7 to 40.0 per cent. At least two explanations of this are possible and our observations enable us to decide that one of these is at least partly responsible. Where the pair of figures are divergent the incidence of plants is high and the plant tillers profusely, giving a correspondingly bigger unit count but smaller individual daughter shoots and plants, advancing the establishment figure reckoned on count, without correspondingly advancing it as

estimated by weight of produce. Since this is so, a wide divergence may indeed indicate vigour of growth and power of colonisation.

Besides, where the figures are divergent it is also possible that with heavy stocking by sheep, which are known to be selective to particular plants in the grazing, a sweet and palatable element in the sward would be cropped low, reducing its representation by weight without seriously affecting its representation by unit count. Conversely those strains where the percentage figures most nearly coincide or correspond as shown in the two different tables are seen to have fewer plants established per unit of space, and have fewer tiller units. They are likely to be less aggressive and successful as colonists and may be they are not as palatable to stock as those whose figures tend to diverge in the two tables. Briefly, we find that by far the most successful establishment whether reckoned by weight or by number of tillers established followed the sowing of Garton's indigenous perennial ryegrass. This is followed by Sutton's indigenous strain, next comes McGill & Smith's, which considerably excels the commercial strain of the control plot. Svalof Victoria ryegrass has proved very disappointing, being considerably poorer than the commercial form on all counts. This is in agreement with earlier observations at Bangor, but does not agree with the experience of workers at the Welsh Plant Breeding Station at Aberystwyth, and of Mr. Johnston-Wallace at Chelmsford.

Finally, where perennial ryegrass prevails as on plots 4 and 6 there is diminution of bent grass and Yorkshire fog. Where ryegrass does not flourish as in plot 8 there is a high percentage of these two inferior grasses, better shown by the percentage frequency method.

Cocksfoot strains and nationalities.

TABLE IV.

	Total tillers in sample.	*Per cent. by weight.*	*Per cent. by tiller unit.*
Garton's Danish cocksfoot (control)	17	2.3	1.1
Garton's mowing English cocksfoot	26	3.5	1.5
Garton's grazing New Zealand cocksfoot ...	94	14.7	5.9
Sutton's indigenous cocksfoot ...	111	12.5	6.0
McGill & Smith's wild New Zealand grazing cocksfoot ...	121	16.1	6.8
McGill & Smith's mowing Scottish cocksfoot ...	86	6.2	2.0

The tiller unit of cocksfoot is considerably bigger than in the case of ryegrass. It should be noted that at the time of examination decayed and burned plants were noted in all the control plots and others containing Danish cocksfoot. These dead plants were left out of the reckoning when the analyses were made.

It should further be noted that though the plots were mown for two years and grazed hard meanwhile, the analyses show up the grazing strains to advantage.

The nationality of the species gives a very striking comparison. New Zealand cocksfoot has been particularly successful in establishing itself. McGill and Smith's wild New Zealand grazing cocksfoot leads, and is followed by Garton's New Zealand grazing cocksfoot and Sutton's indigenous cocksfoot. Then follow the mowing cocksfoot strains, being considerably behind the grazing types. In this class the best is McGill & Smith's mowing Scottish type, followed by Garton's mowing English cocksfoot. Danish cocksfoot sown on the control plot is by far the poorest of all the types sown.

Timothy nationality.

TABLE V.

	Total tillers in sample.	*Per cent. by weight.*	*Per cent. by tiller unit.*
Garton's U.S.A. timothy (control)	31	4.0	2.6
Sutton's American mowing timothy	49	4.6	3.3
Sutton's Scotland grazing timothy	52	5.8	3.0

There is little to comment on here. Sutton's Scotland grazing timothy is slightly better than their American mowing timothy. Both are but little better than the U.S.A. timothy of the control. Conditions of heavy grazing here again do not favour timothy, which consistently thrives best under meadow conditions.

Meadow fescue.

TABLE VI.

	Total tillers in sample.	*Per cent. by weight.*	*Per cent. by tiller unit.*
Garton's U.S.A. meadow fescue ...	4	.3	.2
Garton's English grazing meadow fescue ...	12	.5	.6

Though the proportion of English meadow fescue is higher than that of the U.S.A. type, they alike figure so slightly in the pasture that such variation is of not much significance.

Summary.

The take of various strains and nationalities of perennial ryegrass, cocksfoot, timothy and meadow fescue, in the third year of a ley have been examined both by weight and by tiller unit. Of the species examined perennial ryegrass and cocksfoot show the widest variation of persistency according to nationality and strain. The indigenous types and grazing types have given the best results, and in cocksfoot the nationality of the species proves particularly significant.

The different strains and nationalities of timothy and meadow fescue show little variation as components of the herbage for the conditions ruling over the period of the experiment.

SEEDS MIXTURE PROBLEMS: SOWING AND AFTER-MANAGEMENT.

By WILLIAM DAVIES, M.Sc.,
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Grassland has never been the subject of more intensive nor of more scientific study than during the last few years. It is increasingly realized that better management and better utilization of grassland products is of importance not only to Britain itself but to the Empire as a whole. It is further recognized that high-class temporary leys, although perhaps not always economically profitable, are invariably capable of giving a degree of production far in excess of old pasture.

Having regard to these facts it is important to have accurate knowledge of the factors that influence success or failure in the establishment of a fresh ley. The seeds mixture work conducted at Aberystwyth since 1920 has been directed towards the elucidation of some of these problems and the researches have now reached the point where it is possible to collate the results from various trials and to pronounce a theory of grassland management based on the teachings of the experimental data.

Method and time of sowing.

" Seeds " should be harrowed in on a fine tilth. Grasses and clovers require to be well, but not too deeply, covered and the soil firmly consolidated about them. An average depth of half an inch appears in practice to answer well, but is probably rather deep for the smallest " seeds ", and this may account for the lack of success in the establishment of such grasses as smooth-stalked meadow grass (*Poa pratensis*). Efficient covering is of special importance in the clovers, as has been shown by Williams (8).

For high establishment March, April and May are the best months for sowing in Britain. The influence of sowing date upon establishment and yield is specially pronounced in the high rainfall areas to the North and West and is only slightly less so in the drier East and South of England. Sowing herbage seeds in early August is a practice in some parts of the country, but it is doubtful if in any district sowings can be properly recommended after the middle of June (2). Plants from early sowings are well advanced by the autumn and there is consequently less risk of their being winter killed. In the following spring they are in full vigour and capable of giving high relative yields as hay or pastureage. On the contrary, sowings made late in the season promote an indifferent establishment with heavy winter casualties and the production of weakly " spring " plants, which do not make good growth until late in the first harvest year. The influence of late sowing upon yields is not so pronounced during the second harvest year—a fact intimately connected with the phenomenon of latency and delayed germination (4).

Size of seed.

The relation between size of seed and soil establishment in herbage plants is such that the larger seeded species give the greater number of mature plants from the sowing of a hundred viable seed. This finding has an important bearing upon the compounding of seeds mixtures and affords further proof of what has long been apparent, namely, that seeds mixtures as generally sown have an altogether too high ratio of large seeds to small seeds. This bears added significance when it is realized that this ratio is almost synonymous in practice with that between the top and the bottom species as a pasture.

The efficiency of a pound of viable seed depending not only upon the grain weight but also upon the percentage soil establishment (these being approximately in inverse ratio to one another), it follows that the smaller seeded grasses and clovers have to be sown more heavily than would be indicated simply on a consideration of their grain weights.

Management.

The larger " seeds " not only establish well but make rapid seedling development, producing a large amount of leafage in a relatively short time. Competition on newly sown swards is a function of shading, and the " competitive effectiveness " of any plant during its first year of growth is largely dependent upon its ability for quick and successful establishment followed by further rapid development. A species that grows but slowly from seed and is moreover late in starting active growth in spring is handicapped (under non-grazing conditions) in competition with species that make more rapid and earlier growth. The greater the accumulation of herbage the more intense the competition and the less the survival chances of a non-aggressor species.

Having regard to the fact that seeds mixtures (with the possible exception of those designed for very short term leys) are properly composed of species having widely divergent rates of establishment and growth, excessive competition ought to be avoided until such time as the young pasture becomes well established. The seeding and first harvest years are critical periods in the life of any sward and if excessive growth is allowed to accumulate during these periods the finer grasses and clovers tend to be crowded out and successful pasture formation is thereby jeopardised.

Where permanent grass or long-term pasture is the object a rational system of grazing *should commence as early as possible in the first summer or autumn.* The field should be periodically grazed until late April or even May of the first harvest year, and a light hay crop removed in June or early July. This hay would be young, leafy and highly nutritious, thus compensating to some degree for loss in bulk. The condition of the aftermath is important—it must either be cut back or grazed. Sward spoliation often develops at the latter end of the year, especially when cocksfoot has been sown in appreciable amount and the aftermath neglected.

After the first harvest year minor defects in management may not have consequences so deleterious in effect as those of the first harvest year. It is essential, however, to keep the pasture systematically grazed and manured and to make abundant use of the mowing machine as an implement for cleaning up patchiness and to prevent the inroads and spread of fog, bent and other undesirable species. When a pasture is the final object in view it is not advisable to take hay after the first year, and the latter crop, it is emphasised, should be light, coupled with high nutritive quality.

Seeds mixture.

In the choice of a seeds mixture it should be borne in mind that the number of species should be the minimum compatible with requirements. Simple mixtures are not only less expensive than more complicated ones, but if scientifically blended give better results. The compounding of seeds mixtures is an art requiring considerable knowledge of the agronomic behaviour and potentialities of contrasting species and strains. Each constituent species should be included for a specific purpose; ryegrass, for example, for bulk and long seasonal growth; meadow grass for producing a dense sward preventing the inroads of weed species; while the clovers provide pasturage rich in mineral food constituents.

Seeds mixtures should, moreover, be modified for different conditions of soil and the like. While good strains of perennial ryegrass, meadow fescue and rough-stalked meadow grass give excellent results under conditions of high fertility, they must be partly or wholly replaced by cocksfoot, dogstail and fine-leaved fescue on poor soils. Wild white clover is successful over a wide range of soil types, but may be replaced by a form of *Lotus* at high elevations. Indigenous grasses and the pedigree stocks derived from them are more successful than commercial lots over a wide range of habitat. Similarly with the clovers, wild and Montgomery late red clovers have a wider range of suitable soils than have the early flowering forms of red clover.

Finally, after deciding upon the particular species and strains to be included in the seeds mixture, the relative proportions of each and the actual seed rates per acre have to be determined. It is essential for success that each species should be sown sufficiently heavily to ensure good establishment, and the proportions should be such that the sward produced is an intimate mixture of the sown species. Using scientifically balanced mixtures adds to the chances of success in swarding out well, the possibility of suppression of one species by another is lessened on the one hand as is also that of complete dominance on the other.

The importance of good pasture management is to be emphasised. Bad or indifferent management will jeopardise the successful establishment of a well blended seeds mixture. On the contrary, sowing the most excellent type of mixture will not compensate to any appreciable degree for outrageously bad management of the newly sown ley.

This paper would be incomplete without reference to specific seeds mixtures. The following mixtures are based on experimental work conducted as Aberystwyth—more detailed information may be obtained in a recently published report by Stapledon and Davies (1).

For land of low fertility perennial ryegrass may be replaced by New Zealand cocksfoot at 14 lb. per acre, and rough-stalked meadow grass may be replaced either entirely on in part by crested dogstail. *Lotus major* seeded at, say, 3 lb. per acre may also be introduced into the mixture on the poorer types of land.

Grazing only mixture.

	Seeding in lb. per acre.
Italian ryegrass	10
A good strain of perennial ryegrass*	14
Rough-stalked meadow grass	3
Wild white clover	1 or over

* Either indigenous (*ex* wild white clover cleanings) or Svalöf " Victoria ".

Hay—pasture mixtures in lb. per acre.

Italian ryegrass	Up to 10
A good strain of perennial ryegrass	14
New Zealand cocksfoot	6—8
Timothy	5
Rough-stalked meadow grass	3
A good strain of late-flowering red clover ...	4—6
Wild white clover	1 or over.

Commercial timothy may often be omitted altogether, especially where hay is taken only in the first harvest year. As in the case of the " grazing only mixture ", crested dogstail may replace the meadow grass on the less fertile soils. The seed rate of Italian ryegrass depends on the amount of grazing required in the first autumn and spring. If no grazing is contemplated during the first year of the ley then the seed rate of Italian ryegrass should not exceed 2 lb. per acre.

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SOME STUDIES OF RED CLOVER VARIETIES IN FIELD TRIALS.

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Introduction.

Complaints are common in Caernarvonshire that red clovers do not persist to any appreciable extent beyond the first harvest year. Cases are also met with where hardly any red clover plants are found in the hay in the first harvest year, although present in some abundance in the nurse crop in the seeding year. Such failures are from the writer's experience often due to one or more of the following causes, (*a*) the damage done to maiden seeds by heavy grazing with sheep and by pests like wood pigeons in the autumn and winter months, (*b*) very acid soil conditions, (*c*) the use of unsuitable seed mixtures, (*d*) the sowing of red clover varieties of foreign nationality.

In the following article a summary is given of the results of red clover experiments carried out in the county with a view to ascertaining the relative merits of various English, Welsh, and foreign red clovers in regard to persistency and cropping power.

Centres.

Trials were laid down on two farms in South Caernarvonshire, viz. :—Madryn Farm School, and Penllwyn, Llannor, in 1923 and 1924 respectively. The fields chosen for the trial were divided into ¼ acre plots, and each plot was seeded down with a uniform basal seed mixture containing in addition 1½lb. of seed of one of the following varieties of red clover for each plot :—Chilian, Dorset Marl, Montgomery, Cornish, and Cotswold red clovers.

At Madryn Eastern Counties red clover was tested in addition, while Essex, Brittany, and Vale of Clwyd red clovers were included in the trial at Penllwyn.

The two fields have been cut annually for hay since the trials were laid down.

Classification of the Varieties.

The varieties tested fall into two groups or types, viz., the broad red or early varieties, comprising Chilian, Eastern Counties, Essex, Brittany, and Dorset Marl, and the late flowering varieties or lates including Vale of Clwyd, Cotswold, Montgomery and Cornish Marl. The two types differ considerably in many respects. The late flowering varieties are distinctly later in spring growth and in the time of flowering than the earlies, and produce a more dense prostrate type of growth, a fact particularly noticeable in the aftermaths in these trials. They are also much more persistent than the earlies, as is brought out in the following pages.

Relative persistency of the Varieties.

The main object of these experiments was to ascertain the relative degree of persistency of the varieties tested. The number of red clover plants present in ten separate sections of one square yard was counted on each plot at Madryn in the 1926 and 1927 aftermaths. This was also done at Penllwyn in 1927, but in the case of the second year (1926) aftermath at this centre it was only possible to make counts on one square yard in each plot. The red clovers were found to have tillered considerably when the counts were made, and each tiller having at least five functioning roots was counted as a single plant. The number of tillers found in each plot is given in the following persistency table.

Table giving occurence of red clover plants (tillers) on the plots in 1926 and 1927.

		Madryn.		*Penllwyn.*	
		Total 10 sq. yds.	*Plants per acre in thousands.*	*Total 10 sq. yds.*	*Plants per acre in thousands.*
BROAD RED VARIETIES.					
Chilian	(1926)	0	0	290	140
	(1927)	0	0	18	8
Eastern Counties	(1926)	1	½		
	(1927)	0	0		
Dorset Marl	(1926)	22	10	1,510	730
	(1927)	0	0	98	47
Essex	(1926)			700	338
	(1927)			57	27
Brittany	(1926)			790	382
	(1927)			48	23
LATE FLOWERING RED VARIETIES.					
Vale of Clwyd	(1926)			1,370	663
	(1927)			179	86
Cotswold	(1926)	11	5	2,620	1,268
	(1927)	5	2	325	157
Montgomery	(1926)	1,935	936	4,120	1,994
	(1927)	320	154	1,145	554
Cornish Marl	(1926)	346	167	4,510	2,182
	(1927)	119	57	998	483

The results given in the table are interesting, and it is proposed to briefly consider each centre separately.

Madryn.

The figures represent the number of plants present in the aftermaths of the third and fourth harvest years.

Broad red varieties. The most noticeable feature with regard to these varieties is that they had disappeared completely by the fourth harvest year. A small number of Dorset Marl plants had survived to the third year, while a few isolated plants were noticed on the Eastern Counties plot in the same year. The Chilian had died out by the third year.

It is probable that some of the plants found in 1926 were the result of previous self-seeding of the varieties, and for all practical purposes it may be stated that the broad red types had died out by the end of the third year at this centre.

Late flowering red varieties. The Montgomery and the Cornish Marl had persisted exceptionally well into the third year, and were present in some abundance in the fourth year aftermath. Of the two Montgomery was easily the better in this respect, although it showed a very rapid decline between the third and fourth year.

Cotswold was only present to a very small extent in the two years.

From the results it is evident that Montgomery and Cornish Marl were markedly superior in persistency to the other varieties tested at this centre.

Penllwyn.

At Penllwyn, as has been previously pointed out, counts were made in the second and third year aftermaths, one square yard only being taken in 1926.

Broad red varieties. The results show that these varieties had persisted fairly well into the second year but that there was a pronounced decline by the third year. Dorset Marl was undoubtedly the most persistent of the four varieties and Chilian the least, Essex and Brittany being intermediate between the two. The two former varieties have given better results at this centre up to the third year than was the case at Madryn.

Late flowering red varieties. As compared with the earlies at this centre the lates show very marked superiority in the matter of persistency. This is particularly noticeable with Montgomery and Cornish Marl, which produced about two million plants to the acre in the second year aftermath and half a million in the third year. Rather pronounced differences occur in the persistency figures for these varieties at the two centres in the third harvest year, for whereas Montgomery has given better results at Madryn Cornish Marl has done much better at Penllwyn than at the former centre.

Of the lates Vale of Clwyd has given the poorest results, the variety being but slightly superior to the best of the earlies.

Judging the variety from its habit of growth in the aftermath the writer was forced to the conclusion that the Vale of Clwyd is not a typical late flowering red clover and, without entering into details, it was felt that the variety should be classed as an early-late or a late-early as it appeared to fall into a class intermediate between the true earlies and the genuine lates.

Cotswold proved to be intermediate in persistency between Montgomery and Cornish on the one hand and the Vale of Clwyd on the other.

Effect of red clover on the wild white clover population of the herbage.

In order to investigate what effect the varying abundance of red clovers on the plots had produced on the wild white clover population the aftermath on ten sections of one square yard on each plot at Madryn in 1926 was cut close to the ground, and the produce from each plot was separated into three groups—(1) red clover, (2) wild white clover, and (3) grasses together with weeds. These were then air dried and weighed and the percentage of each class present calculated. It should be noted that the seed mixture used for the plots contained wild white clover at the rate of ½ lb per acre.

Table giving percentage analysis by weight.

Variety.	*Red clover.*	*Wild white clover.*	*Grasses, etc.*
Chilian red clover ...	0	20	80
Dorset Marl ...	trace	17	83
Eastern Counties ...	0	14	86
Cotswold ...	trace	19	81
Montgomery ...	8	14	78
Cornish Marl ...	2	13	85

The word trace in the table indicates the occurrence of less than 1 per cent. of red clover.

As a result of observations made in the field particularly in the 1925 aftermath it was concluded that red clover had a decidedly suppressing effect on the wild clover, the latter being obviously most abundant on those plots in which the red clover was poorly represented. The analysis by weight on the whole bears out this conclusion, although exceptions are noted in the case of the Eastern Counties and Cornish Marl plots.

The results also serve to emphasise the undoubted superiority of Montgomery red clover at this centre.

Yields of Hay in 1925 and 1926.

Owing to unfavourable weather conditions the crop on the Madryn plots in the first harvest year was not weighed, but considerable variations occurred in the amount of red clover present on the various plots.

Eastern Counties and Chilian had failed to establish themselves to any appreciable extent. Of the remaining four varieties Montgomery was by far the best, the clover on this plot being present in such profusion that great difficulty was experienced in harvesting the crop.

The hay crops at Madryn and Penllwyn were weighed in 1925 and 1926, and the weights given represent the yields of hay at the two centres in the second and third and in the first and second harvest years respectively.

The produce on about 60 sq. yards in each plot was weighed green as soon as possible after cutting, and the weight of well-made hay was taken to be one-third of the total weight. No very great significance can be attached to these weights owing to possible errors in accidental choice of sections to be weighed, variations of soil, and the fact that the arbitrary figures for loss of weight makes no allowances for the greater wastage in the case of green hay containing a high proportion of red clover. The results are nevertheless useful and reflect to a fair extent the relative cropping powers of the varieties tested.

Hay Yield Table.

Variety.	*Madryn.*			*Penllwyn.*		
	1925	1926	*Average*	1925	1926	*Average.*
	t. c.	t. c.	t. c.	t. c.	t. c.	t. c.
Chilian ...	2 0	2 6	2 3	1 12	1 6	1 9
Eastern Counties ...	1 13	1 11	1 12			
Essex ...				1 18	1 10	1 14
Brittany ...				1 14	1 11	1 12½
Dorset Marl ...	1 17	2 3	2 0	2 5	1 13	1 19
Vale of Clwyd				2 11	2 1	2 6
Montgomery ...	2 10	2 2	2 6	2 15	2 15	2 15
Cornish Marl ...	1 18	1 5	1 11½	2 5	2 15	2 10
Cotswold red ...	1 15	2 0	1 17½	2 5	1 17	2 1

At Penllwyn the yields obtained are on the whole directly proportional to the degree of occurrence of red clover on the plots, and the superior cropping powers of the late flowering varieties are well brought out in the results. No such definite conclusions can be drawn from the Madryn trial as the yields obtained are conflicting. At this centre Montgomery has done very well, and having regard to its marked superiority in the first harvest year its performance during the three years was outstanding. The late flowering varieties as a whole have cropped better than the earlies even in the first harvest year at Penllwyn, and here again the Montgomery plot has excelled.

The results of the trials and demonstrations in this county with red clover varieties have confirmed those obtained from these experiments with regard to the very heavy yields of hay produced when Montgomery late flowering is included in a seed mixture, and farmers who have tried this variety are very well satisfied with the results.

Conclusions.

1. Late flowering red clovers are far more persistent than the early or broad red varieties. Of the late varieties tested Montgomery and Cornish Marlgrass are outstanding, and are eminently suitable to Caernarvonshire soils and climate.

2. While the bulk of aftermath produced by the lates is appreciably smaller than that of early varieties in the first and second harvest years, the more leafy succulent form of their produce will certainly compensate in quality for any loss in bulk.

3. Vale of Clwyd is not a true late, but should be classed as a late-early or an early-late, as it appears to fall into a class between the true broad red types and the true late varieties.

4. Of the earlies tested Dorset Marl appears to be the best both in regard to persistency and contribution to the crop.

5. The red clover in a seed mixture determines to a considerable extent the bulk of the hay crop in the first two or three years. A late flowering variety like Montgomery is capable of producing excellent crops, and after making due allowance for its slower growth in spring it is questionable whether it is desirable to include a broad red type in a seed mixture for a long ley.

6. Red clover appears to have a suppressing influence on wild white clover, probably due to shading effects. As the red clover dies out the wild white appears to flourish and to spread normally. It is felt that where a strain like Montgomery red is included in a seed mixture the quantity of wild white clover sown can be reduced.

Acknowledgements.

The writer gratefully acknowledges his indebtedness to Dr. R. Alun Roberts for preparing the seed mixtures and for valuable suggestions in connection with these experiments.

TIR GWYLLT YNG NGHYMRU.

Gan Yr Athro G. W. Robinson, M.A.,
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Y mae harddwch naturiol ein gwlad yn ddihareb. Dwg miloedd o ddieithriaid a ymwelant a ni bob blwyddyn er mwyn iechyd a difyrrwch dystiolaeth i'r ffaith hon. Er hynny i gyd, mae'n rhaid addef mai un peth yw swyn gwlad wyllt ac mai peth arall yw ei gwerth amaethyddol. Yn y cysylltiad hwn, y mae'n werth cofio mai peth cymharol ddiweddar yn hanes Prydferthwch yw'r gallu i werthfawrogi'r anialdir. Cyn Mudiad Rhamant disgrifia'n hynafiaid fynyddoedd, rhosydd, a chorsydd, sydd mor ramantus i ni heddyw, fel anialwch diffrwyth a hyll. Er ein bod wedi dysgu i weld harddwch yn yr anialdir, ni raid i ni anghofio fod y miloedd erwau hyn heb eu trin am eu bod yn methu a chyrraedd yr hyn a ddisgwylir oddiwrth dir ffrwythlon. Yn yr erthygl hon ceisir disgrifio rhai o'r prif fathau o dir gwyllt yng Nghymru ac hefyd i drafod y posibilrwydd o'u gwella.

Gwlad y mynyddoedd yw ein gwlad ni; ond er fod y mynyddoedd mor amlwg, nid oes ond rhan gymharol fechan o'n tir yn perthyn i'r dosbarth hwn o dir gwyllt, h.y., tir tua 1,700 troedfedd uwchlaw wyneb y mor na chafodd erioed ei drin ac na fu erioed dan goed. Y mae tir fel hyn yn wyllt am fod y pridd mor deneu a charegog. Yr unig lysiau sydd yn byw mewn lleoedd o'r fath yw y rhai a allant oroesi rhew a stormydd y gaeaf, a sychder yr haf. Y mae tir y mynydd uchel ar yr un pryd y mwyaf godidog a'r mwyaf diwerth o bob tir. Ei unig ddefnydd yw fel porfa deneu i'r miloedd defaid sydd yn crwydro drosto yn yr haf.

Y mae'n debyg fod y cwbl o'n gwlad o dan 1,700 troedfedd yn goed yn y cynoesoedd. Yr unig eithriadau oedd y corsydd, y morfeydd a rhai o'r penrhynnoedd mwyaf agored i'r stormydd. Cymerir cyfle'n ddiweddarach i drin a'r eithriadau hyn, a thraethir yn awr am y tir oedd gynt dan goed. Nid oes ond ambell i lannerch fach o'r cyngoed yn aros erbyn hyn heddyw. Y mae'r rhan fwyaf o'r coed a welir yng Nghymru ar hyn o bryd wedi eu plannu yn gelfyddydol. Un o orchwylion cyntaf ein hynafiaid pan ddisgynasant ar y wlad oedd torri coed i lawr er mwyn cael tir i'w cnydau. Yn ystod y cynoesoedd a'r canoloesoedd fe gliriwyd y coed bron yn llwyr. Y mae'r tir gwar heddyw'n cynnwys y rhannau isaf a mwyaf ffrwythlon o'r tir a fu gynt yn goed.

Rhwng terfynau'r tir gwar a'r mynydd uchel y ceir y rhan fwyaf o'r tir gwyllt yng Nghymru heddyw. Y mae'r tiroedd hyn yn cynnwys cyfres a amrywia o'r ffridd a orwedd ar fin y ffermdir i'r grugdir a derfyna ar y mynydd uchel. Lle nad oes tir uwchlaw tua 1,700 troedfedd, fe geir y grugdir neu'r ffridd yn ymestyn dros bennau'r bryniau. Dibynna uchter y terfyn rhwng y tir llafur a'r ffridd ar ansawdd y pridd. Lle bydd y pridd yn ysgafn a graianog ceir y ffridd a'r grugdir yn ymestyn i lawr i'r gwaelodion. Gwelir yn Llŷn ambell i lethr rhedynog neu rugog yn ymestyn bron hyd i'r mor. O'r tu arall, yn Sir Amwythig, ceir tir llafur ar yr Hen Dywodfaen Goch (*Old Red Sandstone*) yn ymestyn i fyny hyd 1,400 troedfedd uwchlaw wyneb y mor.

Llafuriwyd rhan helaeth o'r ffridd yn amser ein hynafiaid. Bu peth grugdir hefyd yn âr, ond tir a ddadfforestwyd yn unig ydyw'r rhan fywaf ohono. Y mae'n debyg ddarfod i lawer o bridd y grugdir gael ei ddifa ar ol clirio'r tir oddiwrth goed. Y canlyniad oedd difrodi ffrwythlondeb y tiroedd uchel. Gellir esbonio anffrwythlondeb y grugdir trwy'r duedd naturiol yn y fath bridd at ddirywio, ag hefyd drwy'r ffaith fod llawer o'r cynbridd wedi cael ei olchi i ffwrdd gan ddwr rhedegog.

A ydyw'n bosibl gwella'r tiroedd dirywiedig a fu gynt yn goed? Y mae y dirywiad wedi mynd ymhell iawn gyda'r grugdir ac felly nid yw yn debyg y talai am y gost o'i wella. Fe fyddai calch yn un o'r anghenion cyntaf a chan fod y grugdir yn dra sur golygai ddefnyddio cymaint o galch fel ag i wneud y driniaeth yn beth anymarferol. Byddai'n rhaid hefyd wario llawer o arian i glirio ac i drin tir gwyllt fel hyn, ac hyd yn oed wedyn, fe fyddai'r cnydau yn agored i ffaelu drwy sychder yr haf. Unig bosibilrwydd gwella'r grugdir yw ei blannu yn goed. Erbyn hyn, fodd bynnag, mae y rhelyw mawr o'r grugdir hyd yn oed yn anaddas i'r pwrpas hwnnw.

Gyda golwg ar y ffriddoedd, fe edrycha pethau'n fwy gobeithiol. Pe ffynnai amaethyddiaeth, dichon y trinid llawer o'r ffridd eto. Gellir gwella llawer ohono fel porfa gyda gwrteithiau phosphedaidd fel basic slag, neu phosphed Gafsa. Mewn rhai o'r lleoedd goreu y mae'n bosibl gwella'r borfa trwy ddifa y rhedyn a'r eithin sydd erbyn hyn wedi ymdaenu dros lethrau a fu gynt yn borfa dda.

Gellir dweyd am y tir gwyllt rhwng y ffermydd a'r mynydd uchel ei fod yn wyllt oherwydd y duedd at sychter sydd ynddo yn ogystal a'r ffaith fod y pridd mor deneu. Prin y disgwylid gael fod fawr o dir yn tueddu at orsychder mewn gwlad a'i hinsawdd mor wlyb a Chymru. Ond felly y mae. Er fod ucheldiroedd ein gwlad yn llaith yn gyffredin, yn enwedig trwy'r gaeaf, a'r glaw mor gyson, y mae'r pridd mor agored a rhediad dwr mor hwylus oddiarno, nes peri sychter os y peidia a glawio am fwy nag wythnos neu bythefnos yn yr haf. Prinhâ lleithter buddiol y pridd nes diffygio ac y mae amgylchiadau fel hyn yn ddinystriol i'r cwbl ond y llysiau a allant oroesi sychter. Pe byddai'n bosibl troi'r ffriddoedd a'r grugdir yn dir llafur, efallai y byddai'r cnydau yd yn weddol, ond ped heuid y tir gyda hadau gwair, byddai'r mwyafrif o'r mathau gwerthfawrocaf o weiriau farw o sychter mewn blwyddyn neu ddwy. Yn y cysylltiad hwn, byddai'n werth holi ynghylch gwerth eu dyfrhau a dwr y nentydd a redant yn rhydd o'r bryniau yn ddifudd ond i'r pysgod.

Y mae tir tywyn yn fath arall o dir sych. Yma ac acw, lle bydd dwr yn lled agos i'r wyneb, defnyddir y cyfryw dir; ond fel y mae, nid yw'r tywyn fel rheol yn dda i ddim ond fel maes chware golff. Er hynny, dylid cofio fod llawer o dir fel hyn yn cael ei blannu a choed ar y Cyfandir. Prin efallai y gellir disgwyl mesurau mor arwrol yn ein gwlad ni.

Y mae tir gwyllt fel ffridd, rhos, a grugdir yn anffrwythlon ar gyfrif prinder pridd a'i duedd at sychter, ond y mae tiroedd ereill sydd yn anffrwythlon am eu bod yn rhy wlyb. Fe wyr pawb fod hinsawdd Cymru'n llaith dros ben, yn enwedig yn yr ucheldiroedd, ac y mae ym mhob sir yng Nghymru waelodion wedi eu llenwi a'r pridd a olchwyd i lawr o'r ucheldiroedd gan li dyfroedd. Dioddefa gwaelodion fel hyn yn gyffredin oherwydd gormod o ddwr. Lle pery'r gwlybaniaeth drwy gydol y flwyddyn ceir mawnogydd. Fel gyda'r tiroedd sychion y ceir pob gradd, o'r ffridd ar fin y tir llafur hyd i'r grugdir sych, felly hefyd gyda'r tir gwyllt gwlyb ceir pob gradd, o weunydd llaith lle bydd ambell i dwmpath brwyn hyd i'r fawnog a'r merddwr ar ei hwyneb trwy'r flwyddyn. Bu'r fawnog gynt yn llyn fel llawer o gorsydd Môn.

Fe nodir yn awr rai o'r prif fathau o diroedd gwlybion a geir yng Nghymru. Yn gyntaf, ceir tiroedd sydd yn wlyb trwy fod yr isbridd yn gleiog ac yn anhydraidd i ddwr. Cawn y cyfryw diroedd nid yn unig ar y gwaelodion, ond hefyd ar hyd lethrau'r dyffrynoedd. Lle y rhwystrir rhediad naturiol y dwr i lawr i'r nentydd neu'r afonydd gan haenau cleiog, rhed y dwr ar hyd wyneb y tir yn lle cael ei lyncu ganddo. A'r canlyniad ydyw tir gwlyb yn amrywio o borfeydd brwynog i diroedd mawn, fel a geir mewn rhai lleoedd yn Eifionydd ac yn Llŷn ac yn llawer o ddyffrynoedd uchaf Eryri, fel, er engraifft, rhwng Ogwen a Chapel Curig. Diwylliwyd llawer o dir o'r dosbarth hwn yn barod drwy ei sychu. Tir da ydyw ar y cyfan, ond erbyn hyn y mae llawer ohono wedi llithro'n ol am fod y ffosydd yn cael eu hesgeuluso.

Y mae eto lawer o dir fel hyn ac angen ei wella trwy ddrainio, ond y mae'r gwaith yn anhawdd iawn oherwydd fod cerryg yn y clai.

Ceir mewn rhai lleoedd yng Nghymru, er engraifft, yn Rhos Hirwaen yn Llŷn, dir gwyllt a fu gynt yn fawndir, a'r mawn wedi ei glirio i ffwrdd a'i losgi. Go wael ydyw'r cyfryw bridd ar y cyfan am ei fod yn drwm. ac yn sur. Er y llafurir peth ohono, dioddefa gan wlybaniaeth y gaeaf.

Ceisir yn awr fanylu ymhellach am diroedd y gwaelodion. Y dosbarth pwysicaf yw y tir gwaddod (*alluvial soil*). Rhennir y tiroedd hyn yn waddod afonydd a gwaddod mor. Ymestyn gwaddod yr afonydd yn lleiniau hirion ar hyd waelodion dyffrynoedd. Weithiau cawn eangdir llydan o waddod, megis, er engraifft, o bobtu'r Afon Glwyd rhwng Dinbych a Rhuthyn, ac yng nghymer Hafren a Fyrnwy yn ymyl Llanymynech. Tir trwm ar y cyfan yw gwaddod afonydd yn yr iseldiroedd. Graianog ac ysgafn, ar y llaw arall, ydyw gwaddod yr ucheldiroedd. Gyda golwg ar bwysigrwydd amaethyddol tir gwaddod afonydd, cawn arno bob gradd, o'r porfeydd blaenaf hyd i'r gwylltir tlotaf na cheir ond brwyn ar ei wyneb. Gellir gweld pob math o'r gorau i'r gwaethaf yn Nyffryn Conwy. Pe byddai'n bosibl drainio'r math hwn o wylltir, byddai'n ffrwythlon dros ben, ond y mae gwneud hynny'n beth anhawdd iawn oherwydd bod wyneb y tir bron yn wastad a'r afon, ac, felly, nid oes dichon cael digon o rediad dwr. Er hynny, gellid gwneud llawer trwy gadw'r ffosydd yn agored a hwyluso rhediad y dwr o'r ucheldiroedd.

Ceir dosbarth arall o dir gwaddod yn yr aberoedd, h.y., gwaddod y mor, megis yn Sealand, yn y Traeth Mawr ym Meirion, rhwng Casnewydd a Chaerdydd, ac amryw leoedd eraill yn ymyl y mor. Y mae ansawdd y pridd ei hun yn amrwyio llawer. Tir tywod ydyw ar y cyfan yn Sealand ac yn y Traeth Mawr. Ar y llaw arall ceir tir trwm ym Morfa Rhuddlan a rhwng Casnewydd a Chaerdydd. Amrywia'r math hwn o waddod hefyd yn ei werth amaethyddol. Lle bu'r gwelliant trwy ddrainio yn effeithiol ceir tiroedd o'r radd uchaf, yn enwedig fel porfa, ond y mae lleoedd eraill lle na bu'r drainio mor effeithiol, gyda'r canlyniad fod manteision naturiol y fath dir heb eu cwbl ddatblygu. Cymerer, er engraifft, Gors Ddaugae (Malltraeth) ym Môn. Cawn yma filoedd o erwau o dir a'i ansawdd yn ffafriol at amaethyddiaeth gymysg. Bu gynt yn dywod traeth. Cauwyd y mor allan gan argae dros ganrif yn ol. Ni wyddis pa mor effeithiol oedd y drainio ar y cyntaf, ond erbyn hyn y mae cyflwr y Gors yn waeth o lawer nag y dylai fod. Bu peth gwelliant yn amser y Rhyfel trwy waith carcharorion, ond gan na chlirid y ffosydd yn gyson fe lithrodd pethau yn ol eto. Y mae lle i gredu y talai tir Malltraeth am y gost o gwblhau'r drainio. Petasai'r fath dir yn Iseldiroedd y Cyfandir, buasai'n un o'r ardaloedd mwyaf ffrwythlon yn y wlad.

Y mae holl arwynebedd gwaddod-dir Cymru yn lled fawr a'r rhan fwyaf ohono wedi ei arloesi i ryw raddau. Gresyn mawr i gymaint ohono lithro'n ol trwy esgeulusdod. Pe byddai'n bosibl cael arian at y gwaith, talai tiroedd fel hyn yn well nag unrhyw fath arall o dir gwyllt.

Yn ddiweddaf, enwir math arall o dir a debyga i waddod-dir, h.y., tir mewn gwaelodion a fu gynt yn llynnau. Weithiau, gwastadedd brwynog ydynt, ond mewn lleoedd ereill fe gynrychiolir yr hen lynnau gan fawnogydd, fel, er engraifft, Cors y Bol ym Môn a Chors Dregaron yng Ngheredigion. Y mae'r mawn, fel arferol, yn ddwfn yn y cyfryw gorsydd, a phrin y gallem ddisgwyl eu troi yn dir o'r radd uchaf; ond trwy fesurau priodol byddai'n bosibl eu gwella fel porfa.

Disgrifwyd yn yr erthygl hon rai o'r prif fathau o dir gwyllt yng Nghymru. Nid oes cyfle i roddi dim ond braslun o'u nodweddion amlycaf ac i awgrymu'r mesurau a allent fod yn foddion at eu gwella. Y mae amaethyddiaeth ar hyn o bryd mewn cyflwr isel, a chan hynny, prin y gellir disgwyl i ffermwyr neu berchenogion y tir wario arian at ennill tir o'r gwyllt neu ail-enill tir a gollwyd. Er hynny, ni ddylid bod mor anobeithiol a rhoi heibio bosibilrwydd gwella tiroedd gwyllt. Wrth ystyried y posibilrwydd hwn fe fyddai'n fanteisiol cofio fod tir gwyllt yn cael ei rannu'n naturiol yn dir dirywiedig yr ucheldiroedd a thir yr iseldiroedd a gyfoethogwyd gan ysbail yr ucheldiroedd. Byddai'r tir isel hwn yn dda ond fod gormod o ddwr yn aros ynddo yn lle treiglo'n rhydd i ffwrdd. Pe gwaredid y fath dir o'r gormodedd dwr, datblygai ei gyfoeth, sydd yn awr dan glo.

Ar y llaw arall, y mae'r ucheldiroedd yn dlawd ar bob cyfrif ac os na rwystrir y dirywiad fe gredir yr â'n waeth eto. Y mae arwyddion fod y grugdir yn enill ar y ffridd. Lle bydd tir yn cael llafur a gwrtaith y mae'r ffrwythlondeb naturiol yn cael ei ddarbod ac hyd yn oed yn cael ei ychwanegu. Ond gyda golwg ar ffrwythlondeb y tir tu hwnt i derfyn y fferm ceir problem na ddehonglwyd eto. Hwyrach y ceir gwared o'r anhawster hwn trwy blannu'r tir a choed, ond yma yr ydys yn wynebu ar gwestiwn rhy eang i'w drin o fewn terfynau'r erthygl hon.

THE MILK SUPPLY OF ABERYSTWYTH BOROUGH.

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There has been considerable discussion during the last few years with regard to the hygienic quality of the milk supply of many of the cities and large towns of Great Britain. As far back as 1899-1903 the Public Health Authorities of London, Liverpool and Manchester, in order to safeguard the milk supplies of their respective areas, carried out periodic veterinary inspections of the milch cows, and examined milk samples for the presence of Tubercle Bacilli. We find from the proceedings of the National Milk Conference of 1926, which deals with "Milk in Relation to Public Health" that though a good deal of examination for Tubercle Bacilli is being carried out there is very little data pertaining to the hygienic quality of commercial milk as supplied to our towns, available.

A scheme for the improvement and control of the Aberystwyth Milk Supply was initiated early in 1926. This scheme includes educational work among producers and retailers, regular bacteriological examinations of milk samples, in order to ascertain its hygienic quality, together with the dissemination of suitable propaganda among consumers. Inquiries requesting particulars of this scheme have been continually received from various Public Health Authorities in England and Wales. The purpose of this article is to set forth the main objects, methods of procedure and results obtained during the three years during which the scheme has been in operation.

The estimated population of Aberystwyth is 9,135, and during the summer season this is increased to approximately 15,000.

Source of Supply and Methods of Delivery.

It is interesting to find that for the years 1906-07, there were forty-nine milk vendors supplying the Borough.[1] Of these only thirteen were outside the Borough, and of the thirty-six vendors within the area, twenty-five were cowkeepers. The majority of the cowsheds within the town, according to the Medical Officer's annual report for this year, were " old buildings, several of them being temporary wooden structures in a poor state of cleanliness, with unsatisfactory general surroundings ". It is evident that the bulk of the milk supplied in the town at this time was produced in cowsheds within the Borough boundary. We find from various records that the cowkeepers in the town only kept very small herds, the average number of cows per herd being four.

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[1] The authors are indebted to Dr. A. Thomas, the Borough Medical Officer of Health, for data pertaining to the milk supply during the period extending from 1906-26.

The Regulations under the Dairies, Cowsheds and Milkshops Order, 1899, were enforced in 1910, and the effect can be seen in the figures for the next few years. The majority of the small cowkeepers who owned the old wooden structures gave up the milk trade, and by 1912 only ten cowkeepers were left within the Borough. Several of the old cowsheds situated in Mill Street, Pier Street, Bridge Street, and Trefechan were demolished about this time.

The tuberculin test was applied to the cattle kept within the Borough during 1910, when it was found that 4.25 per cent. of the cows reacted positive to the test.

The following table shows the variation in the number of milk vendors during the last twenty-two years :—

Within the borough.				*Cow-keepers outside the borough.*	*Total number of Vendors.*
Year.	*Cow-keepers.*	*Dairies.*	*Total Vendors.*		
1906			36	13	49
1907	26	10	36	26	62
1908			29	26	55
1909			24	29	53
1912	10				
1914			25		
1919			21		
1926	11	12	23	55	78
1927	11	11	22	56	78
1928	11	11	22	54	76

From the above the gradual disappearance of town cowsheds and the development of dairy farms in the rural districts immediately surrounding the town can be observed.

Of the fifty-four farms situated outside the Borough boundary supplying milk to the town at the present time, all but two are within a three miles radius of the town clock, while practically half are within a mile radius of the centre of the town.

The majority of these suppliers within the one mile radius are situated along the Penparke and Capel Sion roads.

As a general rule, it can be said that the farms near the town keep small herds ranging from three to eight cows. The farms outside the two miles radius on the other hand are characterized by bigger herds, ranging from ten to twenty-five cows.

Although considerable variation is found in the type of cow-shed buildings on the sixty-five farms which produce the town's milk supply, about forty or so have fairly good impervious floors, and provision for light and ventilation is above the average.

It is very encouraging to find that the majority carry out the process of milking under really hygienic conditions. The small farmers within the Borough and on its outskirts are especially to be congratulated on their efforts to produce a really clean article.

The utensils too are well cared for and efforts are made to cleanse and sterilise them by the application of boiling water. Only four producers, however, sterilise by means of steam. Very few have milk rooms used solely for the handling and storing of milk, while better facilities for cooling during the summer months are required on the majority of the producing farms. Few of the vendors possess milk coolers and as a result the bulk of the morning's milk is sold in the uncooled state. The milk is delivered once daily during the winter, whilst only a dozen or so retail twice daily during the summer season. The general practice, therefore, is to retail the morning's milk warm, and the evening's milk (in separate churns) at twelve hours old. The evening's milk is generally cooled during the summer by immersing the churns in water tanks for a few hours.

Fifty-two producers retail their own milk, the majority bringing it into town in eleven or seventeen gallon churns, by means of pony milk-floats. A few of these producer-retailers bottle a small amount. The conveyances, churns and bottles are kept reasonably clean.

At present three producers retail Grade A. Tuberculin Tested Milk, whilst another producer retails under a Grade A. licence. In addition, two dairies took out " Grade A." dealers' licences during last summer. A hundred gallons or so of bottled graded milk is thus retailed daily during the summer season.

There are eleven small dairies including milk shops and general stores within the Borough. Like most towns, the conditions existing in some of these shops with regard to the storing and handling of milk are far from satisfactory. The worst offenders are the small general shop-keepers.

Booklets have been issued to the dairies by the Health Authority giving particulars regarding the conditions necessary for the hygienic storing and distribution of milk.

There is a considerable variation in the demand and supply of milk during the year. To meet the increased demand, during the summer season, the smaller cowkeepers add to their herds. It is quite a common occurrence to find cowkeepers who keep four to eight cows in winter increasing the number by 100 per cent. during the holiday period.

The Better Milk Campaign of 1926–28.

On April 16th, 1926, the Borough Council approved a scheme for a Better Milk Campaign, with the following recommendations :

1. That educative work be undertaken amongst the milk producers and distributors with regard to the methods necessary to secure clean milk. This work to be in the form of illustrated lectures, personal visits, talks on the farms and the issue of suitable literature. That a letter be sent to the Aberystwyth Rural Council asking them to also undertake similar work in their area.
2. That an endeavour be made to stimulate a demand for clean milk amongst the public, and that local farms be encouraged to produce Graded Milk.
3. That samples be taken regularly and submitted for bacteriological examination.
4. That steps be taken to educate milk consumers as to the proper care and value of this commodity in the home.

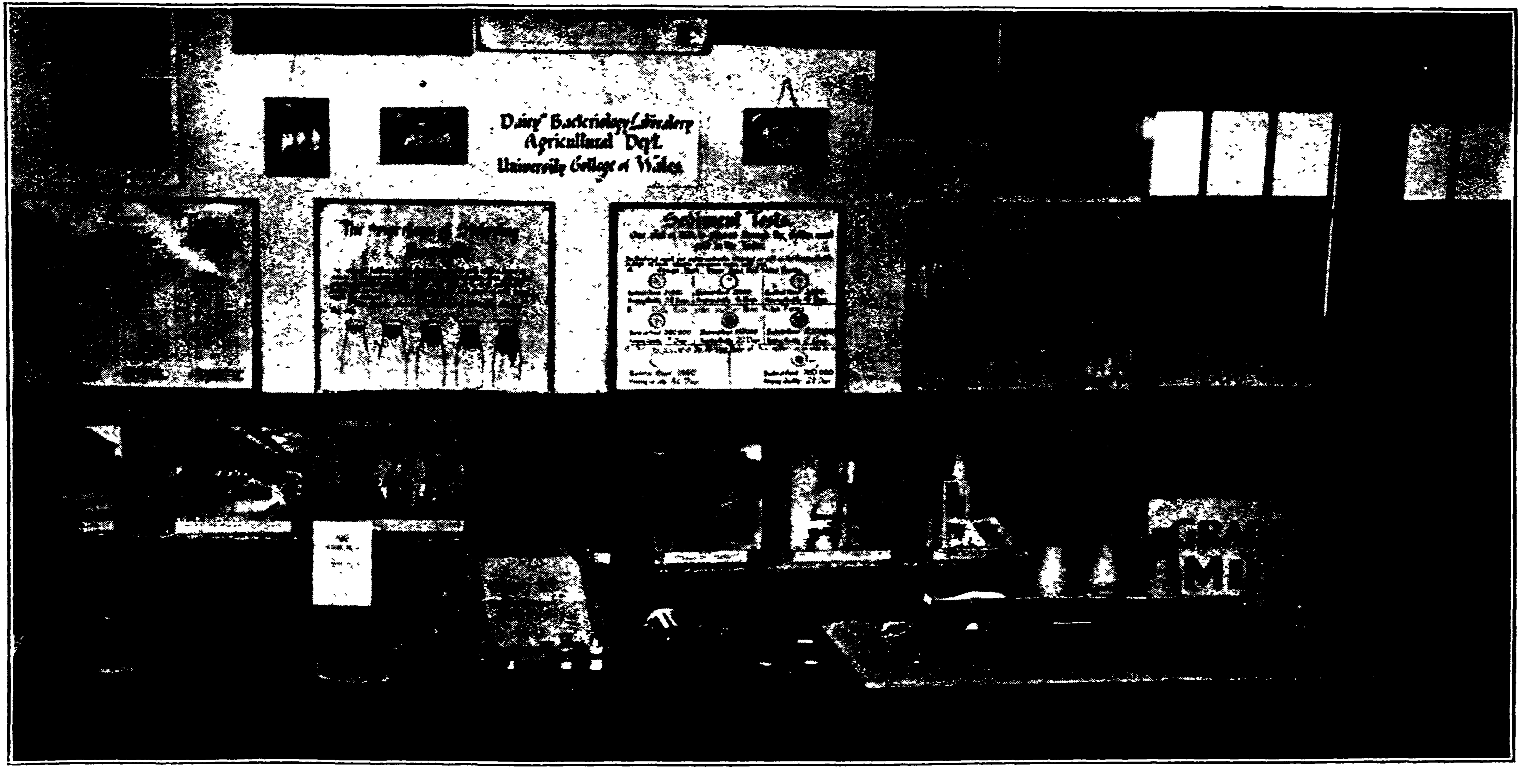
These four points have been borne in mind throughout the course of the campaign, which is now in its fourth year.

The producers and retailers have been visited regularly by the Medical Officer of Health for the Borough and the writers. A considerable amount of advice has also been given by members of the Agricultural Education staff during the course of the County Clean Milk Competitions.

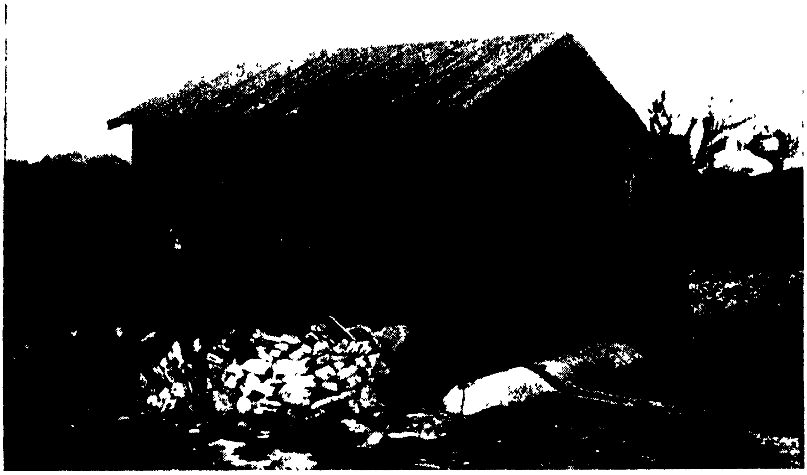
Fourteen producers supplying the Borough took part in the 1927 competition, while fifteen entered the 1928 competition.

During these advisory visits, suggestions with regard to the cleaning of the cows, milking, sterilisation of utensils, and milk cooling were offered. Occasionally small improvements with regard to the actual structure of the buildings were suggested.

Particular attention was paid to the water supply on the farms, as several cases of outbreaks of " ropy milk " had been reported. The water supply of twenty-three farms was examined



ABERYSTWYTH HEALTH WEEK EXHIBITION, 1926.—MILK EXHIBIT.



IMPROVISED MILKROOM ON A SMALL DAIRY FARM.

A WELL-KEPT COWSHED : GROUP B.

bacteriologically, and eight of them were found unfit for dairy purposes.

Booklets giving the essential facts connected with Clean Milk Production were printed and sent to all producers.

The systematic bacteriological examination of milk samples was commenced during June, 1926, and at least one sample has been examined from each supplier annually.

Batches of ten to twenty samples per week were taken on the streets by one of the authors.

In addition, a considerable number of samples from the Borough Milk Supply have been examined during the course of the Clean Milk Competitions, and as the result of advisory and research work carried out by one of the authors. The following table gives the number of samples examined to date :—

	Number.
Campaign, 1926	91
,, 1927	65
,, 1928	61
Clean Milk competitions	256
Advisory	65
Research	110
Official graded samples for Ministry of Health	85
Total	733

The samples during the first season were examined at a standard age of eight hours after milking. For purposes of comparison, however, all samples received after 1926 have been examined when twenty-eight hours old.

The samples are examined for bacterial count, presence or absence of coliform organisms, keeping quality and butter fat content. In addition, a large number of the samples have been examined by means of the Methylene Blue—Fermentation tests, in order to determine the efficiency of these two tests as compared with the bacteriological tests. The results of this investigation will be published during the course of the coming year.

The results for the three years show that a considerable improvement in the hygienic quality of the milk has been made. Of the ninety-one samples examined during 1926, 43 per cent. were up to " Grade A." standards, having less than 200,000 bacteria per cubic centimetre, and no coliform organisms in 1/100th of a cubic centimetre.

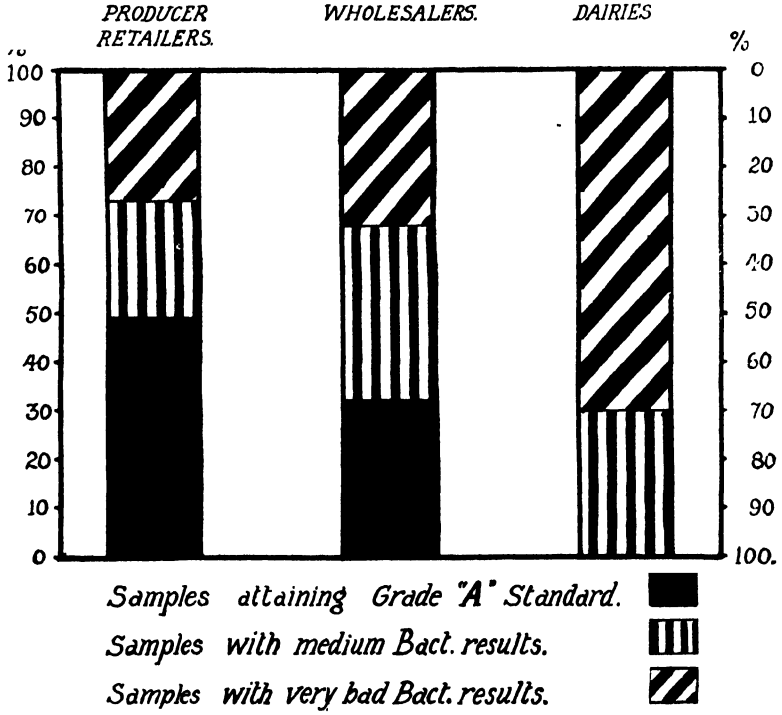
Even though the samples were examined at twenty-eight hours instead of eight hours, during the second year 75 per cent. attained " Grade A." standards. The following result for seven samples from Producer No. 69 shows what improvement can be carried out in a few years :—

	1926 *Aug.* 4.	1927 *May* 18.	1927 *Sept.* 2.	1928 *Feb.* 15.	1928 *Mar.* 7.	1928 *Mar.* 27.	1928 *Apr.* 19.
Bacterial count	2,240,000	95,000	18,600	950	16,500	2,090	1,470
Coliform organisms per cc.	1/1000th	1/1000th	1/100th	Absent.	Absent.	Absent.	Absent.
Keeping quality, days	1½	2¼	2	4	4	3¾	4½

This vendor without making structural alterations of any kind improved his supply to such an extent that he took the first prize in his class in the 1928 Clean Milk Competition.

The bacteriological results show that the milk supplied by the producer-retailers was of a higher standard of cleanliness, and had a better keeping quality than that supplied by the dairies and their suppliers. Graph 1 gives a comparison of the hygienic quality of the milk sampled from the three types of suppliers.

Graph 1.



The bacteriological results from the examinations of nearly five hundred samples during 1926-27 are diagrammatically represented. All samples attaining Grade A. standards are placed in one group, those with medium bacteriological results are placed in the second group, whilst all samples with coliform organisms in 1/1000th of a cubic centimetre, or having a bacterial count over 750,000, are placed in the " very bad " group.

A study of this graph shows that :—

1. The producer-retailers had 49 per cent. of their samples within Grade A. standard, and only 27 per cent. in the " very bad " group.
2. No samples taken from the dairies attained Grade A. standards and 70 per cent. were placed in the " very bad " group.
3. The samples taken from the farmers supplying the dairies were certainly of a higher standard of cleanliness than those from the dairies, but were not up to the standard set by the producer-retailers.

The lower quality of the milk from some of the dairies is probably due to the fact that it is composed of bulked milk in an uncooled state, received from three, or in some cases, six different farms. Bacteriological examination of the milk from groups of farms supplying certain dairies showed that though one or two might have very good milk, there would always be one or more with high bacterial counts.

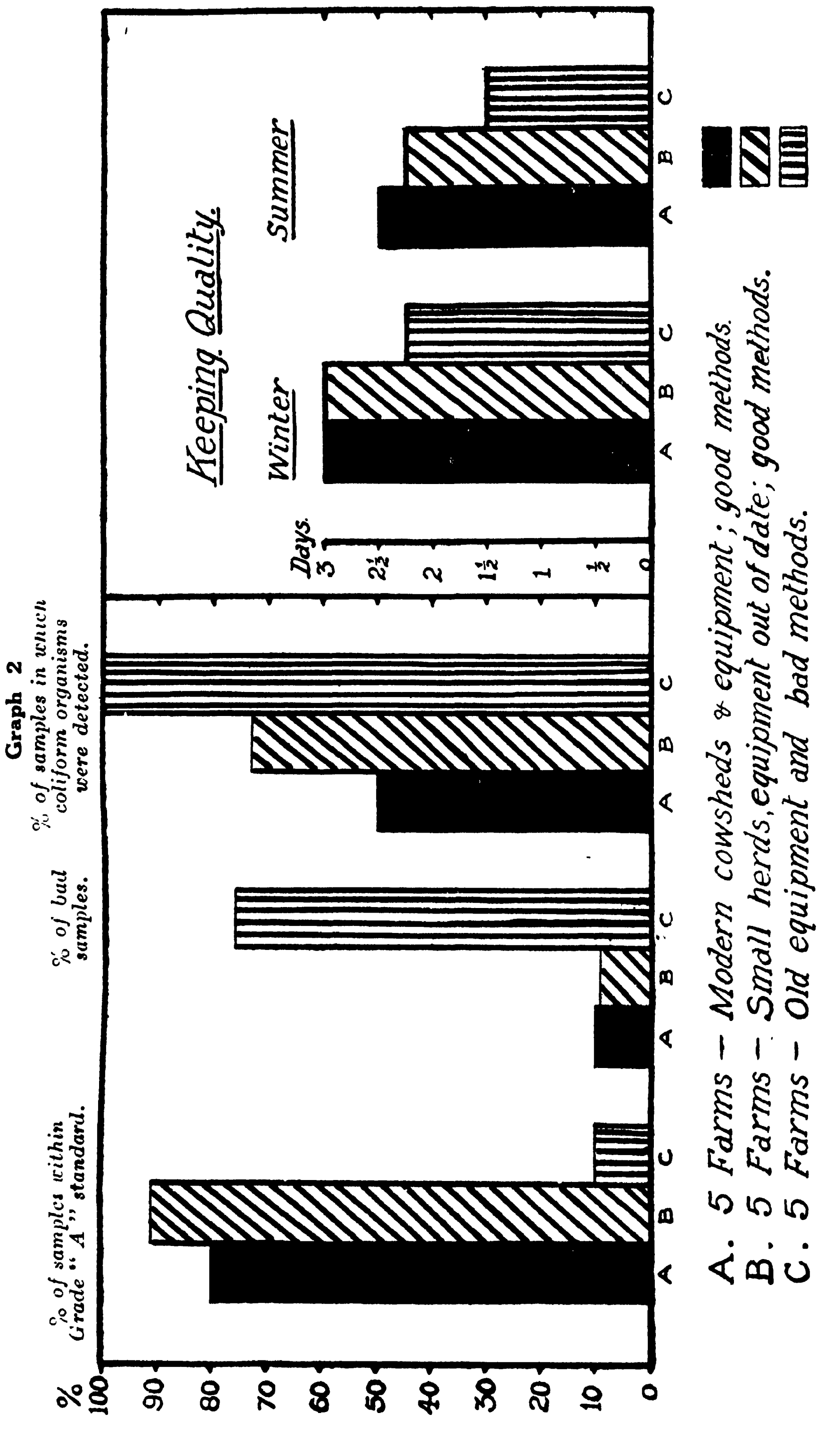
The result of bulking the milk is obvious, the bacterial count and, therefore, the keeping quality is controlled by the weakest link in the chain.

During the advisory visits to the farms particular attention was given to the following items :—Structure and cleanliness of cowsheds, type of utensils used, methods of washing and sterilising same, cleanliness of cows, care exercised by milkers, type and cleanliness of accommodation for handling and storing milk, and general cleanliness in the actual handling of milk.

Bearing these considerations in mind, the sixty-five producing farms can be placed in three main groups :—

A. Half-a-dozen or so which have up-to-date equipment and exceptionally clean methods of production, sterilisation of utensils being carried out by means of steam. Graded milk is being produced on most of these farms.

B. Twenty to thirty small farms (with generally under ten cows in milk) characterised not so much by modern buildings and equipment, but by close attention to details and the adoption of hygienic methods of production.



Graph 2

% of samples within Grade "A" standard.
% of bad samples.
% of samples in which coliform organisms were detected.
Keeping Quality.
Winter
Summer
Days
3
2½
2
1½
1
½
0
%
100
90
80
70
60
50
40
30
20
10
0
A
B
C
A. 5 Farms — Modern cowsheds & equipment; good methods.
B. 5 Farms — Small herds, equipment out of date; good methods.
C. 5 Farms — Old equipment and bad methods.

C. The remainder of the producers where conditions vary considerably, a few making a fair attempt at cleanliness during production, the others leaving room for considerable improvement.

Five farms from each of these groups were taken as typical, and five samples taken from each and examined bacteriologically. Thus twenty-five representative samples were obtained for each group.

Graph 2 gives some of the results of the examination of these samples. Samples with bacterial counts exceeding 750,000 and coliform organisms in such small amounts of milk as 1/1000th of a cubic centimetre, are indicated as " bad ".

It is interesting to find that Group B obtained results of a very high standard of cleanliness, being in some cases quite as good as those in Group A. Results for Group C, however, show high bacterial counts, and the presence of coliform organisms in all the samples. The effect of this is reflected in the keeping quality.

Three series of these samples were taken during the winter months, and two during summer. The keeping quality for the two periods are given separately on the right hand portion of the graph.

A comparison of the keeping quality of Groups A and C shows a difference of eighteen hours in winter and twenty-four hours (one day) in summer.

Of 407 samples examined for fat content, 91 per cent. were found to be up to the 3 per cent. presumptive standard prescribed by the Sale of Milk Regulations, 1901. This compares very favourably with the results of an investigation carried out at Cork City, where 75 per cent. to 89 per cent. of the samples were up to a similar standard.[2]

Reports, together with explanatory notes, are sent to the vendors, after the examination of each batch of samples, whilst one of the writers visits the farm or dairy in the case of an enquiry.

Lectures to Producers.

The County Medical Officer of Health, Dr. Ernest Jones, and the writers commenced on a scheme of lectures to producers during the National Public Health Week. Fourteen of these lectures have been delivered at centres on the outskirts of the Borough, whilst addresses have been given to the Local Milk Vendors' Association.

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[2] Grimes, M. " Urban Milk Supply ", Cork University Press, 1925.

Educational work among Consumers.

Three Clean Milk Exhibitions have been held, two at Aberystwyth and one at Penparke. Over 2,000 persons, most of them consumers, attended these exhibitions, and many of them showed considerable interest in the problem.

Several of the milk vendors gave assistance, showing samples of their milk and various other exhibits.

It is hoped to stage a milk and dairy produce stall at future Public Health Week Exhibitions. Articles on the value of milk as a food, and on the work being carried out in the county with regard to better milk production appear regularly in the local press.

Conclusions.

The main objects of the campaign are undoubtedly being gradually attained. Co-operation has been established between the vendors and the public health authorities. The producers and retailers alike are making considerable improvements. They have realised the importance of milk as a public health factor.

At the same time, the consumer is being made aware of its hygienic quality and its value as a food.

The entire supply of the town is under regular bacteriological control and the consuming public appreciate this fact.

In view of our present knowledge of the milk supply of Aberystwyth, there is reason to believe that it is one of the most hygienic supplies in the Principality.

We have been given figures by various public health authorities during the last year or so, which try to show the wonderful quality of the milk supply of their districts. These figures are too often the results of just a few random samples, and, therefore, they can hardly be a true index of the bacteriological condition of these supplies as a whole.

As far as the authors are aware, the results given in this article are the first to be obtained from a complete bacteriological survey carried out systematically over a period of years by any local authority.

The work must not be left here, and we recommend that the campaign be kept on for several more seasons. There is undoubtedly still room for improvement, and we would suggest that a Better Milk Competition be organised amongst the producers and retailers supplying the Borough in the near future.

"DRY-ROT" OF SWEDES.

By T. Whitehead, Ph.D., M.Sc., A.R.C.Sc.,

and

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The disease which forms the subject of the present paper was first described and named by Rostrup in Denmark in 1898 (6). It was first noticed in this country by Potter in 1896-97, who regarded it as not uncommon in Northumberland and Durham. Although dry-rot is responsible for serious losses in many parts of the British Isles, no account of the disease has been published in this country since Potter's paper appeared in 1900 (5). Dry-rot causes heavy losses also in New Zealand and in recent years the disease has been studied in that country by Bruce Levy and by Cunningham. The latter worker has recently presented evidence to prove that the original name for the dry-rot organism (*Phoma napobrassicae*) must be relinquished in favour of *Phoma lingam*. The present paper summarises the work carried out intermittently at Bangor since 1921, but mainly during 1923 and 1924 with the aid of a special research grant from the Ministry of Agriculture.

The heaviest attack reported in this country occurred in Dorset and is recorded by Cotton (1); the loss was estimated at 720 tons or 90 per cent. of the crop, the monetary value of which was reduced by some £360. In North Wales, crops are to be found every year with upwards of 10 per cent. affected with dry-rot and occasionally very heavy losses result. During the present season (1928) most crops examined in the wetter parts of North Wales were affected, and in several cases from 50 per cent. to 80 per cent. of the roots were either rotten in the field or would eventually become useless in the clamp.

Appearance of the disease.

(1) *On the bulb.* The first noticeable symptom is the appearance of small, pale yellowish spots, oval in shape and with the long axis horizontal. The diseased spot becomes depressed below the level of the healthy parts and has a sharply defined bluish-green margin (Plate 1, fig. 3). Later the spot greatly increases in size, the tissues dry up and minute black fruit bodies, or pycnidia, of the causal fungus burst through the rind at the centre of infection. Owing to the continued drying of the tissues the rind cracks and gaping, transverse fissures are produced (Plate 1, fig. 4); the disease bears no resemblance to any other disease of swede and is therefore easily identified in the field.

(2) *On the leaf.* The occurrence of the disease on the leaf was not mentioned by Rostrup, but Potter definitely states that no case of leaf infection was observed. The present writers noted the presence of spots on swede leaves in 1924, and on microscopical examination the pycnidia were found to be similar to those on the bulb, though smaller and not so deeply imbedded in the tissues. Subsequently cross infections of bulb and leaf were repeatedly obtained in the laboratory, pycnidia being produced and the original fungus re-isolated from the inoculated part. Leaf infections are not mentioned by Bruce Levy in New Zealand (3 and 4), but are discussed by Cunningham (2) without special comment, so that it is probable the leaf disease has been known in that country for several years.

The leaf spots are rather inconspicuous, being either pale green or greyish in colour (Plate 1, fig. 5). In the former case the spot only becomes apparent on the withering of the leaf. Somewhat similar spots occur as the result of infection with a fungus provisionally identified as *Cercospora Bloxami*, but in this latter case the affected part of the leaf is conspicuously blanched and no black pycnidia develop. The dry-rot disease may be present on both leaf and bulb of the same plant or it may occur only on one or the other. Continuous discoloured patches have been observed connecting diseased spots on the " neck " of the bulb and the leaf blade.

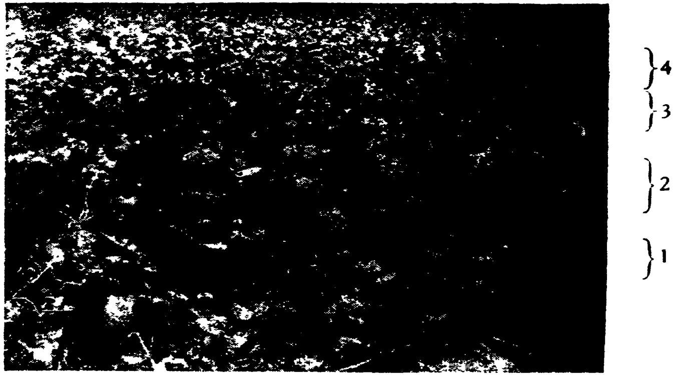
(3) *In the field.* The disease is not distributed uniformly throughout the crop but occurs in patches which do not appear to bear any relation to the contour of the field or to the texture or moisture content of the soil. Each diseased patch usually includes one or more very badly rotted roots, generally near to one edge of the patch, and a number of plants progressively less affected the further removed they are from the badly affected ones. If, as usually happens in North Wales, the crop is left out until the new year many of the affected roots will either have rotted completely away or, at any rate, will be unfit to cart from the field. The typical appearance in the field is shown in Plate 1, figs. 1 and 2.

Notes on the cultural characters of the fungus.

Germination of spores from the current crop of pycnidia takes place as a rule within twenty-four hours, but those obtained from three-year-old pycnidia show retarded germination and growth, followed by a complete arrest of growth in a few days. Immersion of spores in water for two days greatly reduces the germination capacity. On germination the short rod-like spore swells to almost

PLATE

Fig



Fig

Fig. 3.

Fig. 5.

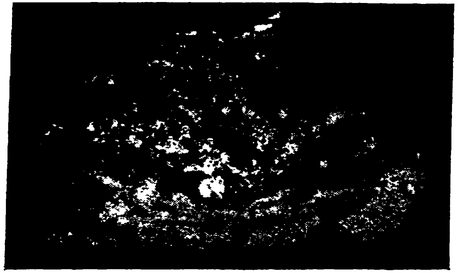


Fig. 4.

PLATE 2.

FIG. 1.

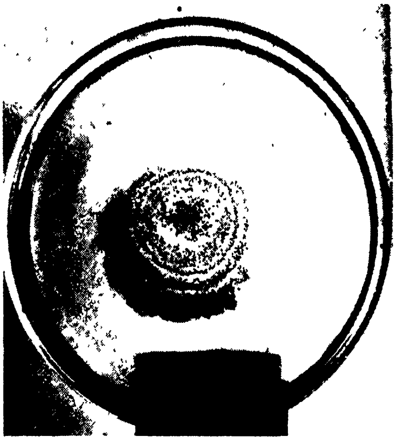


FIG. 5.

FIG. 3.

FIG. 2.

FIG. 4.

PLATE 3.

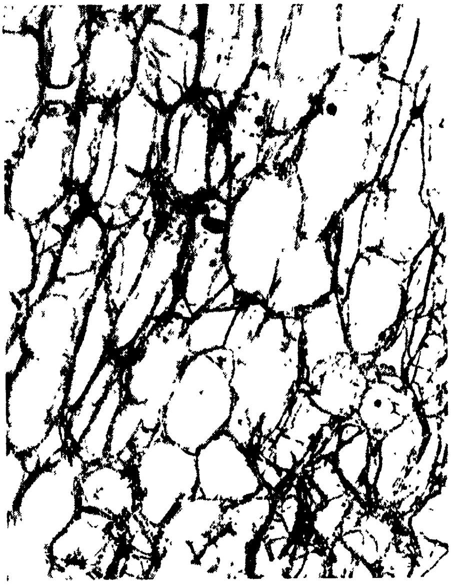


FIG. 1.

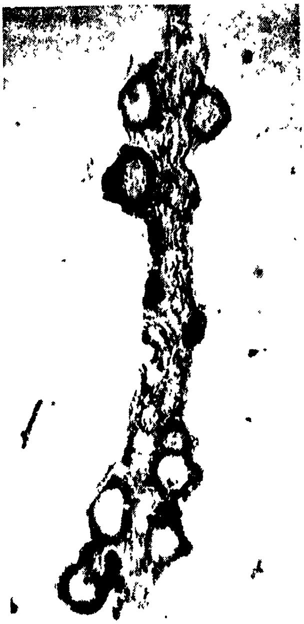


FIG. 3.

FIG. 4.

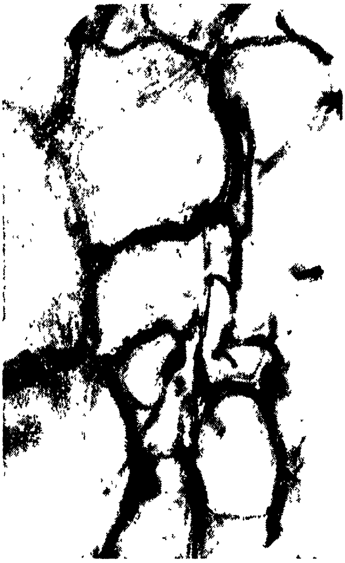


FIG. 2.

double its original size. The germ tube is at first cylindrical but very soon becomes globular. It is not usual, however, for numerous globular swellings of the germ tube to develop as occurs in *Phoma betae.* Occasionally two germ tubes are produced, in which case they may develop from opposite poles of the spore or one may arise equaterially. Mycelial development is profuse on agar swede-extract + 5 but is slow on the same medium at + 15 and — 15, the alkaline medium inducing the production of brown, thick-walled chlamydospores. Germination begins on a medium of pure starch, but development is quickly arrested, the same thing occurring to a smaller extent on potato-extract media. Both mycelial growth and pycnidial development are much better on media containing albuminoids (as in bean-extract agar) or sugars (as in mangold extract agar). Monosporous cultures on swede-extract agar produce concentric waves of mycelial growth with pycnidia in rings corresponding to temporary cessation of mycelial growth. Such cultures quickly stale and no surface growth occurs after about eighteen days, although pycnidial development continues (Plate 2, Fig. 5). In plates and hanging drops pycnidia form in about ten days but twenty-four days usually elapse before they develop on slants. Exudation of spores from the pycnidia begins as a rule within a few days after the latter have become quite black. If ample moisture is present a continuous stream of spores is ejected for some fifteen minutes in the form of a pink tendril in which the spores are embedded in mucilage. Under drier conditions the tendril is hard and horny and of a deep red colour. The optimum temperature for growth of the fungus lies in the neighbourhood of 25°C but pycnidial formation is more rapid at 20°C.

The fungus in the host tissues.

Infection occurs either through a lenticel, leaf-scar or a wound. The writers have found no evidence that infection can take place through the unbroken rind, although Potter implies this in his paper (5). The invading mycelium is at first largely distributive in that it spreads between the cells of the outer cortex in a tangential direction. There appears to be some relation between the long, transverse lenticels and this transverse spread of the fungus. A typical spot increased during two months from 5.5 cm. to 7.0 cm. in a transverse direction and from 1.6 cm. to 3.2 cm. vertically on a bulb. The penetration into the deeper tissues is even slower and it is still confined to the outer layers when pycnidial formation begins. As the hyphae penetrate into the inner tissues of the bulb the cells enclosed by them collapse and the hyphae develop intracellularly (Plate 3, figs. 1 and 2).

Judging from its inability to destroy filter paper when grown in pure cultures, the fungus produces no enzyme capable of dissolving the cellulose walls of the parenchyma cells. The phloem and many layered cambium are ramified by the fungus and the hyphae frequently wrap themselves round the wood vessels, and occasionally penetrate the walls. Pycnidia form first at the point of infection and develop progressively from this point as the spot enlarges. They are produced at varying depths in the tissues and only those on or near the surface of the rind possess black, thickened walls; the deeper seated ones being almost devoid of pycnidial wall. When a thick shaving was taken from the rind of a diseased bulb so as to remove the superficial pycnidia, the deeper ones gradually appeared on the cut surface as whitish, globular bodies which later turned brown and then black.

Initial attack in the field.

The cause of the first outbreak of dry-rot in the field each year is, of course, of the first importance. Conceivably this might be due to (1) sowing infected seed, (2) infection of the swede crop from other crop plants or weeds, (3) contamination of the soil, or to a combination of any of these methods.

(1) *Seed infection.* From the commencement of this work it has been regarded as extremely probable that the disease is seed-borne, especially since it has been conclusively shown in U.S.A. to occur in blackleg of brassicas caused by the same fungus, and in closely allied diseases such as heart-rot of mangolds (*Phoma betae*).

If, however, dry-rot is seed-borne, one would expect to find evidence of its presence at a very early stage in the growth of the crop, and this the writers have failed to do, notwithstanding a careful search in many crops over a period of five years. Indeed the disease has never been seen in North Wales earlier than September, and it is usually well into October before dry-rot is to be found in the field. The proper place to study seed-borne diseases is, of course, a seed growing area, but since seed is not grown in North Wales the writers have had to rely on testing commercial samples. Many such efforts to isolate the fungus responsible for dry-rot, by sowing seed on agar plates, have been made without success, so that by 1925 the writers regarded the question as settled in the negative. Recently, however, Cunningham (2) has given strong evidence that the disease is seed-borne in New Zealand, a conclusion which is supported by Bruce Levy's observations on the heavy loss in the field in that country due to dry-rot in seedling plants.

Immediately the writers became aware of these results, further efforts were made to demonstrate the occurrence of the fungus on commercial seed in this country. Through the courtesy of the National Seed Testing Station, sixty-seven samples of seed were obtained and were grown in 100 seed lots in sterilised soil, but no dry-rot lesions, as described by Cunningham, could be found on the plants at any stage in their growth. Again, these samples, together with five others bought from merchants—making a total of seventy-two—were planted out in 100 seed lots in agar, Cunningham's technique being followed exactly except that neutral cauliflower agar was substituted for his dextrose agar. Previous work by the writers had shown that the fungus would grow luxuriently on the cauliflower agar, but although many well known saprophytic organisms developed in the plates, no fungus resembling Phoma was seen.

It is, of course, impossible to prove a negative, but the writers are of the opinion that seed infection either does not occur in this country or, if so, it can only rarely be responsible for outbreaks of dry-rot in the swede crop. In this connection it is of interest to note that Cunningham has separated the dry-rot fungus into three strains, of which No. 1 is weakly parasitic, No. 2 is strongly so, and No. 3 is purely saprophytic. He includes the fungus obtained from British and Danish seed in No. 1 strain, but considers the form isolated by the writers from British bulbs —a culture of which was sent out to him—to differ markedly enough to justify its inclusion in No. 2 strain, to which also belong the forms Cunningham isolated both from seed and bulbs of New Zealand origin. One must, therefore, conclude that (1) dry-rot of the swede bulb is caused by the same fungus in both countries; (2) although the fungus occurs frequently on New Zealand seed in a virulent form it either does not occur at all on British seed or, if Cunningham's view is accepted, it occurs only in an attenuated or devitalised form not likely to be capable of initiating dry-rot attacks on the bulb in the field.[1]

(2) *Infection of the swede crop from other crops or weeds.* Parasitic Phomas have been found by the writers on only two of the herbaceous weed plants common in swede fields, i.e., *Polygonum persicaria* (Redshank) and *Polygonum sp.* It is scarcely possible that the initial attack can be due to cross infection from

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[1] Since the above was written, a letter by Murphy in *Nature* (No. 3,062, Vol. 122, p. 18, 1928) claims that careful examination of Cunningham's cultures proves his No. 1 strain—as represented by one culture received from Cunningham—to be quite possibly not a Phoma at all, and certainly a distinct fungus without connection with the organism causing dry-rot. He also reports his failure to isolate *Phoma lingam* from swede seed.

either of these weeds, since the fungi appear to be distinct from the one causing dry-rot of swedes. Furthermore, the development of these weeds is co-terminous with that of the swede, and no relationship has ever been found between either the occurence or intensity of disease in swede and on the weeds.

With regard to other crop plants, the Phoma occurring on mangold is certainly distinct, and in any case does not attack the mangold before neighbouring swedes show dry-rot. Brassicas, however, in the Llandudno Junction area are often attacked by a Phoma which, on the evidence of cross inoculations and behaviour in pure culture, appears to be identical with the swede dry-rot fungus. It is conceivable that autumn sown brassicas might carry on the disease in this way from one swede crop to another, but the cases in which this sequence of crops is taken is extremely small and their very rarity rules this out as the usual means of infecting the swede crop.

(3) *Soil contamination.* With the disappearance of seed infection as a potent cause of the initial outbreak in the swede crop, the importance of soil contamination becomes evident. That the soil must become contaminated is obvious since badly rotted roots are left in the field and thousands of fruit bodies of the fungus must in this way be returned to the soil. The likelihood of these fruit bodies being responsible for setting up disease in the next crop is very great, for, although the length of time during which they can remain viable in the soil has not been determined, they have been shown to contain viable spores after three years' storage in the writers' laboratory. On many farms in North Wales it is customary for diseased swedes to be thrown on the manure heap, and this doubtless is a most effective way of ensuring an outbreak in the next swede crop. The danger of contaminating the soil by feeding diseased swedes to sheep on temporary ley was demonstrated on one farm in Denbighshire, resulting in this case in a severe attack on land where the disease had not previously been seen. In the sheep fattening areas of the South of England, where swedes are sometimes taken twice together in the rotation and the crop fed off to sheep on the field, it is extremely probable that the outbreak is directly due to rotting roots, either remaining on the surface of the soil or ploughed in.

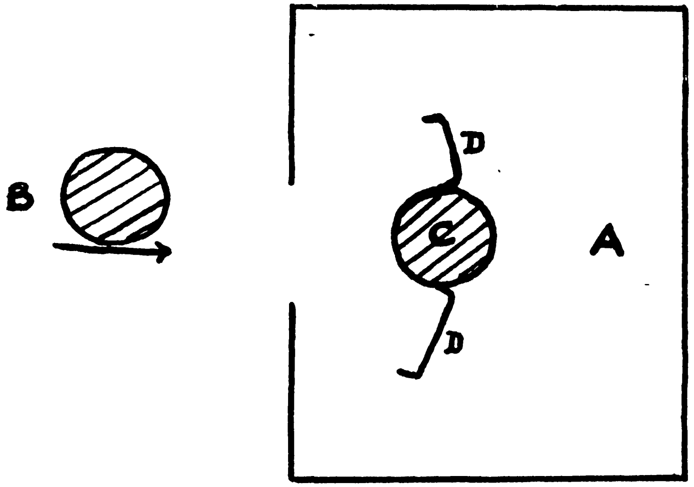
Spread under field conditions.

The fact that even the worst patch of infected plants will invariably contain bulbs showing only the earliest stage of the disease, i.e., depressed spots without any sign of pycnidia, clearly indicates that some spread occurs in the field from the heavily infected plants. Even a casual inspection of an affected crop points to the wind as being the main cause of the distribution of the disease spores from rotting plants to healthy ones. Detailed notes as to the position of the diseased spots on the bulbs in four plots were made in the winter of 1924 in the hope of obtaining some estimate of the importance of wind in spreading infection. The prevailing winds were from the south or south-west and swept along the rows, so that the portion of each bulb facing north and east was relatively sheltered from the wind. In the following Table I, which gives the results of an examination extending from November 24 to January 24 in two plots, and from December 29 to January 24 in the other two, the position of the diseased spots is given for those bulbs obviously infected from their neighbours, and does not include the few original infectors.

TABLE I.

Plot.	*Number of bulbs.*	*Number secondarily infected.*	*Per cent. infected.*	*Number infected on exposed sides.*	*Per cent. infected.*
A	351	24	6.8	17	70.9
B	397	54	13.6	48	88.9
C	375	49	13.1	35	71.4
D	319	31	9.7	29	93.5

Confirmatory evidence that the disease is mainly distributed by the wind was obtained by transplanting plants in such a manner that each diseased plant was surrounded by healthy ones. Invariably, diseased spots first appeared on the side of those bulbs which would intercept spores blown from the infectors.



TEXT FIG. 1.

Under moist conditions the spores exude from the fruit-bodies of the fungus in the form of gelatinous tendrils which, however, become hard and horny if dry weather intervenes before the spores can be dispersed. In order to determine whether spread of the disease could occur even in dry conditions when the spores are congealed in this horny mass, the following experiment was carried out (Text Fig 1.). By means of a foot bellows a current of air was blown past a diseased swede (B) on to a healthy one (C) placed in a culture chamber (A), which had been previously steam sterilised. Open petri dishes (D) containing solid swede-extract agar + 5 flanked the swede (C) to act as spore traps. In the first experiment the spore tendrils on the bulb (B) were hard and horny, but afterwards they were thoroughly moistened and the experiment repeated—with, of course, a new healthy swede and petri dishes in the chamber. To test the condition of the atmosphere both inside and outside the culture chamber, petri dishes were previously exposed in the chamber and a current of air was also blown past a healthy swede outside the chamber on to a similar one inside. All the swedes were finally removed from the culture chamber, marked, and placed in a covered moist chamber, the petri dishes being incubated at 25°C. The results are given in Table II.

TABLE II.

Infector.	*Appearance of swede in culture chamber.*	*Appearance of petri dish spore trap.*
Healthy control.	Remained healthy.	Contaminations but no Phoma developed.
Dry tendrils.	Numerous spots after 23 days; pycnidia did not form.	Many Phoma colonies. Pycnidia formed.
Moist tendrils.	As with dry tendrils.	As with dry tendrils.
———	———	Control agar plates had no Phoma colonies.

The atmosphere of the laboratory was distinctly moist and it is evident from the result of the experiment with dry tendrils that spread of the spores can occur even under such conditions.

The occurrence of disease spots on the leaves at once suggested, of course, that the movement of wet infected foliage might facilitate the spread of dry-rot through the crop, or alternatively, that the canopy of leaves would afford some protection to the bulbs. Indeed the growing of swedes close enough to produce a complete canopy of foliage has been suggested by Bruce Levy (4).

as a method of controlling the disease in the field. Unfortunately the writers have only very rarely been able to trace any kind of relation between the extent of the disease on the foliage and bulb. In the majority of cases leaf infection is only slight whether bulb infection is heavy or not. Where leaf infection has been heavy, the bulbs in every crop except one have also proved to be badly attacked—indicating that the foliage has afforded little or no protection under North Wales conditions where swedes are grown in rows about 26in. wide and the canopy of leaves, especially in autumn, when the disease is spreading, is far from complete. Again, although pycnidia readily form on the leaf spots the writers have never seen them dehisce in the field, so that it would appear to be far less likely for the disease to be spread from leaf to leaf than from the tendrils on the bulb.

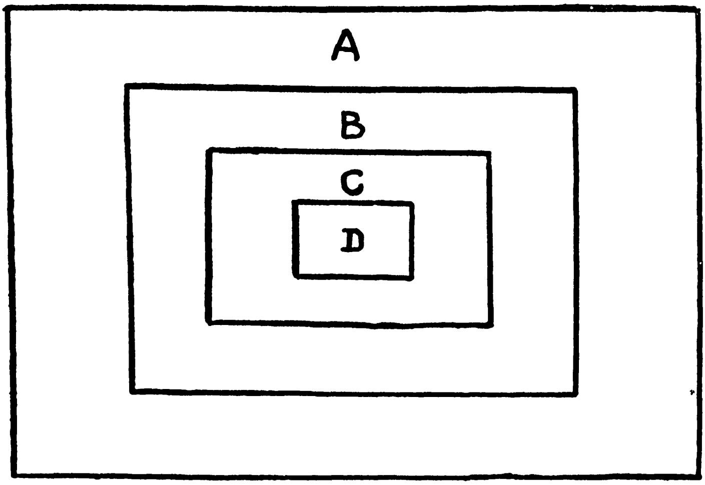
Diseased spots on the bulb are often rasped by slugs and it is frequently possible to tell whether the slug damage occurred before or after development of the disease, *e.g.*, Plate 1, fig. 3, shows slug damage inflicted at the centre of a spot already developing. Although wounds, whether produced by mechanical means or the agency of animals, are certainly not necessary for infection to occur, there was every likelihood of their facilitating infection by removing the tough rind of the bulb. Notes have therefore been made whenever possible as to the relationship between slug bites and infection, but as the following Table III shows, such wounds are of no importance in increasing the spread of the disease.

TABLE III.

Plot.	*Slug-bitten before disease.*	*Slug-bitten after disease.*
A	2	3
B	3	11
C	4	15
D	0	7
Total ...	9 (20%)	36 (80%)

Development and spread of dry-rot in the clamp.

It is a common experience to find that bulbs, apparently sound when clamped, become affected with dry-rot after storage. Such a condition may arise either by the spread of disease from a few affected bulbs or by the inclusion of bulbs which have already been infected in the field but show no signs of disease on clamping. Experiments to test both these possibilities are described below. In one experiment 828 swedes which appeared perfectly healthy on close inspection, but which were obtained from a crop badly affected with dry-rot, were clamped on December 26, 1924. After two months' storage the clamp was opened and the percentage disease ascertained in the different " zones " of the clamp as illustrated in Text Fig. 2.



Text Fig. 2.

The result, which is given in Table IV clearly shows that nearly 90 per cent· of the bulbs were already infected before they were clamped.

TABLE IV.

Zone.	*Total bulbs.*	*Number diseased.*	*Per cent. diseased.*
A	432	371	85.4
B	200	183	91.5
C	136	116	85.3
D	55	49	89.1
		Total per cent. diseased =	87.4

In the previous winter clamping experiments had shown that dry-rot is able to spread from diseased to healthy bulbs in storage. Apparently healthy bulbs were selected, after careful examination, from a crop almost entirely free from dry-rot. These were clamped in two heaps as described below, badly rotted bulbs from another crop being introduced into the centre of each clamp as a source of infection.

Clamp 1 was made on January 1, 1924, and contained twenty healthy bulbs with one diseased one in the centre. All the bulbs were diseased when the clamp was opened fifteen weeks after.

Clamp 2. This contained 1,243 healthy bulbs with four infectors at the centre. It was constructed on December 24, 1923, and opened on May 9, 1924. By means of an iron pipe fixed in the clamp so that one end touched the infectors in the centre and the other projected outside, a record was kept of the maximum and minimum temperatures at the centre of the clamp —the thermometer, inside the pipe, being pulled out at about fortnightly intervals to enable the temperatures to be taken. The lowest temperature reached was 30°F, the highest 64°F, and the mean 44.2°F. When opened the clamp was divided into outer, intermediate, and inner zones, and the extent to which the disease had spread is shown in Table V.

TABLE V.

Zone.	*Number bulbs.*	*Number infected.*	*Per cent. infected.*
Outer ...	580	278	47.93
Intermediate ...	527	359	68.12
Inner ...	136	110	80.88

The high percentage of disease even in the outer zone was surprising, but the progressive increase in infection from the outside to the centre of the clamp—both in number of bulbs affected and in the intensity with which they were attacked—conclusively shows that the disease does spread under ordinary conditions of storage.

Control of the disease.

The difficulty of planning experiments to test various methods of controlling dry-rot is very greatly increased by the occurrence of the disease in patches in the field, and by the seasonal variation in the intensity of attack· For instance, the variety trial at Llandudno Junction, described below, was carried out on land on which the swede crop had been almost completely ruined in 1922 and where the succeeding crop of broccoli was also badly affected, yet only 16 per cent. infection occurred in the trial in 1924. It is, therefore, not suggested that the trials described below do more than indicate certain promising lines for further work in controlling dry-rot.

(A) Variety Trials. The briefest summary only is given of observations made since 1921.

1921. Percentage infection in a ten-yard strip across the varieties at Clynnog, Caernarvonshire; the varieties being given in the order of their occurrence in the plot. Lord Derby 5.5, Danish Studsgaard 0.0, Magnum Bonum 15.6, Driffield Pioneer

34.1, Danish Herning 10.3, Dreadnought 38.0, Victor Turnip 2.8, Lord Derby 64.7, Danish Studsgaard 47.5, Magnum Bonum 53.2, Pioneer 24.0, Danish Herning 0.0, Dreadnought 0·0, Victor Turnip 0.0.

The disease had obviously spread from a source of infection near the centre of the plots. Lord Derby is clearly very susceptible, as is also Magnum Bonum, Pioneer, and Dreadnought, whilst the yellow turnip "Victor" is markedly resistant. The same seed stocks were sown on two other farms where, however, practically no disease developed.

1922. Only a trace of dry-rot occurred on any of the variety trials in this year.

1924. At Llandegfan, Anglesey, the percentages of dry-rot were as follows :—Webb's Empire 1.08, Danish Studsgaard 0.74, Danish Herning 0.13, Yellow Turnip 0.0.

At Llandudno Junction, Caernarvonshire, the results were —Lord Derby 16.1, Danish Studsgaard 5.08, Yellow Turnip 1.75

Yellow Turnip is again seen to be resistant and the slight infection of the Danish varieties suggests that they merit further trial.

1928. Variety trials laid down in South Caernarvonshire under the supervision of Mr. E. Jones, M.Sc., of the Madryn Castle Farm Institute, were examined by one of the writers. Table VI gives the percentages of dry-rot found by inspection of not less than 500 roots in each case. Trials in duplicate were also laid down at three centres in Flintshire and three in Anglesey, under the direction of the County Organisers. Detailed counts of infected plants were not made but the extreme susceptibility of the variety Lord Derby was evident on all six farms. In Flintshire the Danish variety also was very badly affected. The same stocks of seed were sown on all the farms as well as on the College Farm in the trial referred to below.

TABLE VI.

Variety.	*Farm A.*	*Farm B.*	*Farm C.*	*Farm D.*
Conqueror ...	0.8	—	—	—
Superlative ...	4.9	39.6	27.2	1.0
Model ...	5.7	18.5	13.8	0.0
Lord Derby ...	35.0	64.6	31.6	4.1
Magnum Bonum ...	11.7	32.3	1.6	0.3
Danish Studsgaard ...	—	—	4.6	0.3

Two series of trials were laid down at the College Farm, Aber, Caernarvonshire, and with the exception of two varieties in the first series, the extent of the rotting in each diseased plant was noted; a badly affected bulb being one likely to be left in the field when the crop was lifted, whilst use could be made of a slightly affected bulb if fed to stock without much delay. The results are given in Table VII.

TABLE VII.

Variety.	*Number diseased.*	*Per cent. diseased.*	*Number badly diseased.*	*Per cent. badly diseased.*
Up-to-Date ...	183	37.0	—	—
Danish Studsgaard ...	166	33.5	93	18.8
Superlative ...	191	38.6	—	—
Lord Derby ...	301	60.9	156	31.5
Magnum Bonum ...	124	21.1	47	9.5
Model ...	187	37.8	69	13.9
Up-to-Date ...	201	40.6	91	18.4
Model ...	240	48.5	108	21.8
Magnum Bonum ...	224	45.3	83	16.8
Lord Derby ...	311	62.9	128	25.9
Superlative ...	165	33.4	43	8.7
Danish Studsgaard ...	118	23.8	25	5.1

When all the trials are considered, the only conclusions that can be drawn with confidence, since they are supported by many other observations in the field, are the extreme susceptibility of the variety Lord Derby to dry-rot and the marked resistance shown by the yellow turnips usually grown in North Wales. Although some varieties of swede such as the two Danish strains, and the British Superlative and Model, give evidence of some degree of resistance, the difficulty of estimating such resistance owing to the infectious nature of the disease is very great. The degree of attack is evidently affected by the position of the variety relative to such a susceptible kind as Lord Derby, and this factor can only be eliminated by randomising the variety plots in a chequerboard trial. Although such a trial was laid down in 1922 only a trace of dry-rot developed. It has been found impracticable to repeat the trial on private farms where the disease has occurred, owing to the impossibility of forecasting the extent to which the crop would be affected and the probability that club-root would be serious on the trial plots.

(*B*) *Effect of Artificial Manures.* Several references are to be found in Danish literature to the occurrence of dry-rot of swedes and heart rot of mangolds on well-limed soils, and Potter's statement (5) that he could readily infect swedes which had been grown on the Cockle Park Farm plots but was unsuccessful with swedes from the College garden also suggests some change in the constitution of the plant as a result of different manurial treatments. With this possibility in view, a careful note has been kept of the incidence of dry-rot in manurial trials with swedes from 1921 to 1924, but, as the following summary shows, no relation has been traced between the manures applied and the intensity of attack by the dry-rot fungus. In 1921 only a trace of disease occurred on the superphosphate plots on one farm, whilst 21 per cent. of the plants grown with sulphate of ammonia developed dry-rot. On two other farms where the same stocks of swedes were cross dressed with lime, slag, and guano, practically no disease appeared on either control or treated plots. The suggestion that sulphate of ammonia had increased the amount of disease in 1921 was followed up in 1922, when variety crops were cross dressed with this manure at the rates of 1 cwt. and 2 cwt. per acre. The plots were in duplicate and alternated with three control plots. All the plots were almost entirely free from dry-rot. In 1923 the variety Up-to-Date was sown at the College Farm on land cross dressed the previous year with lime at the rates of 17 cwt. and 34 cwt. per acre, and the disease appeared in patches which cut across the plots without any relation to the dressing they had received. Precisely the same result was obtained in a crop of the variety Magnificent, cross dressed with eight different phosphatic manures applied in quantities sufficient to give 50 lbs. total P_2O_5 per acre. At Llandudno Junction in 1924 the trials were cross dressed with sulphate of ammonia and with sulphate of potash at the rate of 4 cwt. and 2 cwt. per acre respectively; the result being : sulphate of ammonia 5.56 per cent. disease, sulphate of potash 4.99 per cent., control, 7.14 per cent., the difference clearly being insufficient to permit conclusions to be drawn. Incidentally, it may be mentioned that at this centre two other plots were heavily watered with 5 per cent. formalin before sowing. The treatment was quite ineffective since 5.56 per cent. of dry-rot developed in these plots.

(*C*) *Rogueing out Diseased Plants in the Feld.* Two plots of eight rows, each fifteen yards long, were marked out in November, 1924, in a crop severely affected with dry-rot. On eight successive dates every plant was examined and the diseased ones removed. Two other plots were similarly rogued, beginning on December 29. Table VIII gives the percentages of disease found on those plots at each examination.

The rise in the number of infected plants noted on December 29 is doubtless due to the development of disease in plants already infected on November 24, since under laboratory conditions there is an interval of three weeks or one month between

TABLE VIII.

Plot.	*Nov. 24*	*Dec. 2*	*Dec. 8*	*Dec. 18*	*Dec. 29*	*Jan. 7*	*Jan. 15*	*Jan. 24*
A	6.66	1.17	0.58	0.98	2.79	0.28	0.91	0.66
B	19.06	1.85	0.59	3.75	3.88	2.42	2.43	2.28
C	—	—	—	—	13.15	1.42	0.40	1.83
D	—	—	—	—	15.28	0.99	1.35	0.00

the time of inoculation and the first appearance of disease. It is this incubation period of the disease in the plant which necessitates frequent rogueing out of the affected bulbs. Although a more complete control would certainly have been obtained by beginning to rogue as soon as disease first appeared in the plots, the results given justify the belief that repeated rogueing is an effective way of preventing the spread of dry-rot in the crop.

(D) Control of the Disease in the Clamp. Experiments were made in 1924 to try to find some means of checking the rotting of bulbs in the clamp. Apparently healthy bulbs were selected from a rather badly infected crop, so that it could be assumed that a proportion of the bulbs had already been infected in the field with the dry-rot fungus and would show signs of rotting after the clamp was opened. Six clamps were constructed on various dates in December and opened two months later. Each clamp included four diseased bulbs at the centre to ensure infection, and five clamps were treated with different substances to test their effect on preventing the development of dry-rot. When opened, the clamps were divided into zones as illustrated in Text Figure 2, and the percentage diseased bulbs in each zone was determined. The results are very briefly set out below.

Clamp 1 contained 725 apparently healthy bulbs. As these were placed in layers in the clamp 28 lbs. of flowers of sulphur were dusted over them. When opened, an average of 76.0 per cent. infection was found in all the zones.

Clamp 2 contained 1,018 bulbs, and these were dusted with 40 lbs. of ground limestone, with the result that 58.67 per cent. average infection developed.

Clamp 3 contained 990 bulbs, which received no treatment, and showed 77.07 per cent. infection when opened.

Clamp 4 contained 808 bulbs, which received 80 lbs. of ground lime, and showed an average of 75.21 per cent. infection when opened.

Clamp 5, with 800 bulbs, remained untreated except that the four diseased bulbs were soaked for ten minutes in 5 per cent. formalin before being placed in the centre of the clamp. An average of 66.76 per cent. of disease developed in this clamp.

Clamp 6 contained 818 bulbs, which were sprayed with an 8 per cent. solution of formaldehyde on clamping, five litres being required for the purpose. When opened, an average of 68.09 per cent. of disease was found.

Taking Clamp No. 3 as the standard, the various treatments reduced the disease in the clamps by the following amounts :— Flowers of Sulphur, 1.07 per cent., Ground Limestone, 18.4 per cent., Powdered Lime, 1.86 per cent., Formalin (5 per cent.) immersion of infectors, 10.18 per cent., Formalin (8 per cent.), 8.89 per cent. Ground Limestone gave the best control but by no means sufficiently good as to justify its being recommended for trial. The 8 per cent. formalin damaged the rind and made diagnosis difficult, whilst the flowers of sulphur and powdered lime made the bulbs very dirty.

Summary.

(1) The paper is concerned mainly with the agricultural aspects of the " dry-rot " disease of swedes.

(2) A brief account is given of the cultural characters of the fungus and its relation to the swede tissues.

(3) Evidence is submitted to show that the initial outbreak in a crop is due largely to the introduction of diseased material from the manure into the field, and not to infection from other crops or weeds. Seed infection, if it occurs at all, is of little importance.

(4) The spread of the disease in the field is by means of wind-borne spores. Slugs are not agents in carrying spores, but by rasping the rind, they may increase the number of plants affected.

(5) Apparently healthy swedes from a diseased crop may show infection after clamping, and actual spread of dry-rot from diseased bulbs in the clamp has been demonstrated.

(6) The variety Lord Derby has been shown to be very susceptible, whilst yellow turnips are distinctly resistant.

(7) Artificial manures have had little or no effect on the amount of disease present in a crop. This, however, may possibly be due to the fact that in all the trials the crops received farm yard manure and this may have tended to mask the effect of the artificials employed.

(8) Rogueing out diseased plants in the field gave a measure of control, and, if begun as soon as dry-rot can be identified in the crop, probably affords the most practical means of eradicating the disease.

(9) Dressing the bulbs on clamping with Ground Limestone somewhat reduced the development of dry-rot, but not sufficiently to justify its being recommended.

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EXPLANATION OF ILLUSTRATIONS.

Plate 1.

Fig. 1. Badly attacked crop of the variety " Magnificent ".

Fig. 2. Variety Trial at College Farm, 1928.
1, Magnum Bonum. 2, Lord Derby. 3, Superlative. 4, Danish Studsgaard.

Fig. 3. Typical Dry-Rot Spot, showing shrinkage of rind with blue-green margin, pycnidia and a wound produced by a slug after pycnidial formation.

Fig. 4. Swede, showing transverse fissure.

Fig. 5. Infection on swede leaf. Several stages shown from the earliest appearance of the spot to torn, dried up spot with pycnidia.

Plate 2.

Fig. 1. Neck and leaf infection of swede.

Fig. 2. Natural infection of Polygonum persicaria and Polygonum sp. with Phoma sp.

Figs. 3 and 4. Spore tendrils (in centre) on swede rind. × 40 and × 200 respectively.

Fig. 5. Monosporous culture of *Phoma lingam* from swede on swede-extract agar+5, after staling.

Plate 3.

Fig. 1. Section of infected swede tissue, showing (left) intercellular hyphae and (right) intracellular hyphae × 120.

Fig. 2. Intercellular hyphae in swede tissue, showing shrinkage of cell walls. × 400.

Fig. 3. Natural infection of broccoli leaf with *Phoma lingam*, showing pycnidia. × 140.

Fig. 4. Infection of broccoli stem produced by inoculation with spores of *Phoma lingam* from swede. × 1/1.

OBSERVATIONS ON THE CONTROL OF WEEVILS OF THE GENUS *APION* ATTACKING RED CLOVER.

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Introduction.

Weevils of the genus *Apion*, several species of which attack red clover in Wales, are responsible for two types of injury, the adults feed on the foliage, and the larvae either in the flowerheads on the young ovules, or in the stem according to the species concerned. The species possessing flowerhead feeding larvae are *apricans*, *assimile*, and *trifolii*, and from the point of view of clover seed production it is, of course, these species only which are important, and to which the following observations relate.

Without in any way attempting a detailed historical account, it may be said that these small weevils have been recognised as pests for many years, Linneaus having been aware of their economic status. One of the earliest attempts to estimate the extent of loss in seed production was made in 1798 by a Mr. Markwick, who communicated the results of his observations to the Linnean Society in 1801 (1). He calculated that on 4½ acres, his loss amounted to 9¼ bushels of clover seed, worth £28 2s. 6d., and that the loss was due to damage caused by the larvae of *Apion apricans*. In 1848 M. Guerin Meneville published a pamphlet (2) on the insects injurious to agriculture, and in it included observations on the life history and economic status of *Apion apricans*, while Curtis in 1860, in his work on the life histories and economy of insects injurious to field crops (3), deals with the life histories of *Apion apricans*, *A. assimile*, and *A. flavipes* (*dichroum*), and offers suggestions for their control. Subsequently, although comparatively little work has been done on the subject, *Apion supp.* have received the attention of investigators both in this country and on the continent.

While it is not proposed to give a full account of the life history of the weevils in the present paper, it is nevertheless necessary to give sufficient details to explain the reasons for the following experiments and observations.

The adult, but not yet mature, weevils hibernate under shelter, and in the spring, from the middle to the end of April, emerge, and commence feeding on clover foliage. This feeding is usually unimportant, but it sometimes happens that the young spring growth is retarded by climatic conditions, and in such circumstances the partial defoliation produced by adult feeding causes a further, and sometimes severe check.

Maturation and fertilisation takes place, and egg laying commences about the middle of May, the eggs being laid singly, and only in green flowerheads before the individual florets have opened. Commencement of egg laying and the duration of the laying period are closely related to conditions of wind and temperature, and the laying period may extend to from 5-6 weeks. The egg stage is similarly dependent, varying from 4-6 days. The young larvae on emerging commence to feed on the developing ovules. Three larval instars occur, and the total larval period averages eighteen days, during which 7-10 ovules are eaten. The larvae are very sensitive to conditions of humidity, and are killed by dessication of the flowerheads, such as occurs during the haymaking process.

The pupal period averages about six days, but may be extended by lack of humidity up to 10-12 days. There is, however, no evidence to show that dessication is fatal to pupae as it is to larvae.

The weevils on emergence mature and pair, and a second generation of larvae is produced, whose habits and history are similar to those of the first generation. The adults arising from the second brood larvae feed for a while and then hibernate. There are thus two generations per annum, but owing to the very extended egg laying period there is no clear line of demarcation between the two, and considerable overlapping occurs.

In order to realise the bearing of the life history of the clover seed weevils upon seed production, it is necessary to discuss, briefly, methods of seed production, which differ according to the variety concerned. With a non-persistent, early flowering variety such as English broad red, the first cut is taken for hay, and the second cut for seed.

With a late flowering persistent variety such as Montgomery red, the most common procedure in the seed growing districts is as follows :—The clover is sown under corn in April, and in the first harvest year is cut for hay about the second week in July. The aftermath is usually grazed, a second hay crop rarely being taken. In the second harvest year, the crop is either grazed until the end of May, or cut for hay at about that date. It is then kept up for seed, which is harvested from the middle to the end of September. The fact that dessication of the flowerheads such as occurs during the haymaking process is fatal to *Apion* larvae gave rise to the major part of the investigations described below.

It is clear that there must be a stage in flowerhead development in the crop as a whole, when the majority of the *Apion* population is in either the egg or the larval stage, that is, vulnerable to dessication, and therefore a hay crop taken at this stage would result in the maximum amount of larval mortality. If the cut were taken earlier, *i.e.*, before egg laying had finished; or later, *i.e.*, when the majority of the larvae had pupated and were thus invulnerable to dessication, the degree of *Apion* mortality would be lower.

The possibility, therefore, of reducing the numbers of the *Apion* population of a clover stand being grown for seed by taking the previous hay cut at the optimum time is also clear.

With such a clover as English broad red, this hay cut would of course be taken in the seed harvest year, but with Montgomery red the procedure is necessarily different. With the latter variety, even if the stand were left entirely undisturbed, head production would not have commenced by the end of May, the date when the stand is kept up for seed. It is obvious, therefore, that when dealing with Montgomery red clover, anti-weevil operations are confined to reducing the *Apion* population of the seed crop in the pre seed-harvest years. The question of clover stands not destined for seed production will be referred to later. The following experiments and observations all relate to Montgomery red.

The effect of the hay cut on larval destruction.

As has already been stated, the haymaking process causes the death of the larvae, and the series of experiments now to be described represent an attempt to ascertain what effect the time of the hay cut has upon larval destruction. Also, since variation in time of cutting might affect the yield, information was collected regarding the total yield and aftermath. The experiments were commenced in 1924.

The following mixture was sown on June 16 without a nurse crop, the grass seed being broadcast, and the clover drilled :—

Perennial rye grass ...	7.5 lb. per acre.
Cocksfoot	5.0 lb. per acre.
Tall fescue	6.4 lb. per acre.
Montgomery red clover ...	10.8 lb. per acre.

Subsequent treatment of the stand was as follows. During the first harvest year it was grazed intermittently until the middle of April, and then kept up for hay. Before putting up for hay the area was marked out into sixteen one-hundredth acre plots, 58ft. 5in. long by 9ft. wide. The plots were separated by cross paths, 8ft. wide, and long paths, 2ft. wide, they were marked out by running the plough lightly along the margins of the paths.

To counteract a slight unevenness of soil, the plots were arranged on the Student Method according to the following plan (paths not shown).

1d. Early cut.	CK8. Medium cut.	1b. Early cut.	CK1. Medium cut.
CK4. Medium cut.	1c. Early cut.	CK2. Medium cut.	1a. Early cut.
2d. Late cut.	CK7. Medium cut.	2b. Late cut.	CK5. Medium cut.
CK8. Medium cut.	2c. Late cut.	CK6. Medium cut.	2a. Late cut.

The plots were subsequently cut at three different dates, and as will be seen, the medium cut plots were used as controls, giving four early, eight medium, and four late cut plots. Before cutting the plots, the paths were first carefully cut with a sickle, the plots themselves being cut with a scythe. Dates of cutting were as follows :—*Early cut,* July 6, the clover being in the early bud stage, that is, the majority of the flowerheads on the main stems had only just formed; *Medium cut,* July 20, when the clover was in nearly full flower, that is, 50-70 per cent. of the main stem flowerheads in bloom; *Late cut,* August 6, when the clover was in the early seeding stage, that is, 75 per cent. of the main stem flowerheads were brown. The aftermath was cut on all plots on the same date, September 17, with a mower.

Methods of obtaining the necessary data were as follows :—The green produce was weighed on the field immediately after cutting, to avoid loss of weight by evaporation. A 3lb. sample was taken from each plot immediately after cutting, and air dried. The dry weight for each plot was calculated from the green and dry weight of the sample, and the green weight of the plot. A sample of about 2lb. was also taken from each plot and separated into clover and grasses. The two portions were air dried, and the dry weights of clover in each plot calculated from the data so obtained.

The data relevant to *Apion* destruction were collected as follows :—As the time of cutting, 1,000 heads were collected at random from each plot, put into canvas bags, and hung up for three weeks to air dry. Each head separately was then pulled to pieces, carefully examined, and the whole of the insect fauna removed and subsequently identified.

The results of the experiment are given in the following tables :—

TABLE I.

Showing the number of adults and larvae.

Figures for each plot are not given separately.

Plots.	*Adults.*	*Larvae.*	*Total.*
Early cut. 4000 heads.	50	170	220
Medium cut. 8000 heads.	242	390*	632
Late cut. 4000 heads.	18	60	78

* Includes one pupa.

TABLE II.

Showing the average Apion population per 1000 heads.

Plots.	*Adults.*	*Larvae.*	*Total.*
Early cut.	12.50	42.50	55.00
Medium cut.	30.26	48.74	79.00
Late cut.	4.50	15.00	19.50

TABLE III.

Showing the percentage of the Apion population killed by each cut.

Plots.	*Percentage killed.*
Early cut.	77.25
Medium cut.	61.7
Late cut.	76.9

It is important to notice that after dessication by bagging and hanging to dry, no living larvae, and only one pupa, which was dead, were found. This bears out the statements that dessication, while fatal to larvae, is innocuous to pupae, which are able to reach the adult stage.

In assessing the true value of the three cuts in reducing the *Apion* population, several factors must be taken into consideration. Examination of the tables shows that the total *Apion* population of the heads was very much larger at the time of the medium cut than at the early cut. This indicates that at the early cut egg laying by the weevils was not completed, which is borne out by the fact that the majority of the larvae found in the heads from the first cut were in either the first or second stage. The fact that all the larvae found in the heads from the medium cut were in either the second or third stage shows that at the time of the medium cut egg laying had been completed. If the figures showing percentage population killed are examined, however, it is seen that although the actual number of weevils present at the time of the second cut was much larger, the percentage of them that were killed is lower than that for the first cut. This indicates that at the time of the second cut a large number of the larvae had pupated and were so able to survive dessication.

It would appear, therefore, that the first cut, that is when the clover was in the early bud stage, was too early for maximum larval destruction, since egg laying was not complete, and that the second cut, when the clover was in 50 to 70 per cent. full bloom, was too late, since although egg laying had finished, a large number of the weevils had reached the pupal stage and were able to survive. With regard to the late cut, the figures show that the weevil population of the heads was very small at that period, indicating that almost all the weevils had reached the adult stage and left the heads. On the other hand, a high percentage of this weevil population at the late cut was killed by dessication. This is explained by the fact that over 50 per cent. of the larvae in the flowerheads at the time of the last cut were first stage larvae. Since all first stage larvae of the first brood had disappeared by the time of the middle cut, these later ones must have belonged to the second brood.

This experiment indicated, therefore, that the optimum period for cutting to ensure maximum weevil destruction lies somewhere between the early and medium cuts, that is, when the maximum number of eggs and larvae, and the minimum number of pupae are in the heads, and it seemed possible that this period might be somewhere around the 25 per cent. full flower stage. An experiment carried out to test this theory will be described later.

With regard to the second portion of the experiment now being described, that of determining the effect of the different times of cutting on the yield, the following data were obtained :—

TABLE IV.

Showing average weights in lb. per plot.

Plots.	*Hay.*		*Aftermath.*		*Total Yield.*	
	Weight air dry.	*Weight clover air dry.*	*Weight air dry.*	*Weight clover air dry.*	*Weight air dry.*	*Weight clover air dry.*
Early cut.	50.9	27.7	22.4	16.9	73.3	44.6
Medium cut.	59.4	35.2	15.3	9.5	74.7	44.7
Late cut.	61.8	42.8	6.2	2.1	68.1	44.9

TABLE V.

Showing total yields in tons per acre.

Plots.	*Hay.*	*Aftermath.*	*Total.*
Early.	2.27	1.00	3.27
Medium.	2.65	0.68	3.33
Late.	2.71	0.27	3.01

It will be seen from Table V that compared with the medium plot, the yield of early cut hay was lower by 0.38 tons per acre. The aftermath of the early cut was, however, nearly twice as large as that of the medium cut, and the difference between the total yields was negligible, being only 0.06 tons per acre in favour of the medium cut. In the case of the late cut plots, although the yield of hay was the largest, the aftermath was so small that the total yield per acre was the lowest. Examination of Table IV shows that the variation in total yield is almost entirely due to variation in the grass content, as the clover yield is remarkably even.

It would appear from this experiment, therefore, that varying the time of hay cut within the limits of the experiment had a negligible effect upon the total yield.

In the following season, opportunity was taken to test the theory derived from this experiment, that the optimum time of cutting to ensure maximum larval destruction might be when the crop was in the 25 per cent. full flower stage. Since the question of comparative yields had been gone into, as described above, this portion of the experiment was not repeated, and no definite experimental plots were laid down. The heads used for the observations to be described were taken from a stand of clover hay in its first harvest year, the red clover being entirely Montgomery late flowering. Samples of 4,000 heads were picked at three periods, *July 7*, when the crop was in the early bud stage, as in the previous experiment; *July 15*, when about 25 per cent. of the heads were in full flower; and *July 23*, when 70 per cent. of the heads were in full flower. The heads were bagged as in the previous experiment, and examination commenced three weeks after bagging. The method of picking the heads was as follows :—Plants were selected at random from all over the field, and every head picked from each plant, until the requisite number had been obtained. This ensured that the sample was typical of the flowerhead conditions obtaining in the crop as a whole. The data relevant to weevil destruction are given in the following Tables :—

TABLE VI.

Showing the numbers of adults and larvae obtained from each sample of heads.

Sample.	*Adults.*	*Larvae.*	*Total.*
Early bud stage.	23	89	112
25% full flower.	55	182	237
70% full flower.	26	46	72

TABLE VII.

Showing the percentage of Apion population killed in each sample.

Sample.	*Percentage killed.*
Early bud.	79.4
25%	76.7
70%	63.9

Examination of Table VI shows that when 25 per cent. of the flowerheads of the crop were in full flower, the *Apion* population of the heads was more than double the population at the early bud stage, showing that egg laying was still in process at the latter stage. It will be remembered that this stage was defined earlier as the period when the majority of the flowerheads on the main stems had only just formed. Eggs are laid only in green flowerheads before the individual florets have opened, and it is evident that at the early bud stage head production is not sufficiently far advanced to permit of maximum egg laying activity in the crop as a whole.

Table VII shows that the percentage of the *Apion* population killed at the 25 per cent. full flower stage is only slightly less than the percentage killed at the early bud stage. The majority of the larvae at the 25 per cent. full flower period were second stage larvae, but larvae in first and third stages also occurred. This indicates that although egg laying had not necessarily finished at this stage, it was probably near completion.

It would appear, therefore, that when the clover is in 25 per cent. full flower the following conditions obtain :—the *Apion* population of the flowerheads is high; egg laying is at all events nearing completion; and the percentage of the *Apion* population vulnerable to dessication is high. It is highly improbable that having regard to the many and variable controlling factors, that the optimum time of taking the hay cut in order to ensure maximum weevil mortality can ever be defined with any great degree of preciseness, but it is clear from the experiments described that if the cut is taken when the crop is in 25 per cent. full flower, mortality is very high.

In addition to clover stands destined for seed production, many of the farms in the seed-producing districts have clover stands which are not destined for seed production and which are never cut for hay. The grazing on such fields is often very poorly done, with the result that the clover plants produce large numbers of heads, and are in flower practically throughout the year. This is clearly advantageous to weevil increase, and running the mower over the field when the majority of the flowerheads are noticed to be in the 25 per cent. full flower stage is clearly to be recommended both for weevil destruction and for other reasons, such as maintaining a finer sward, which cannot be fully entered into here.

With regard to aftermaths, which are almost universally grazed, the grazing is also often very poor, but head production in the aftermath is almost non-existent and therefore unless some particularly favourable season leads to considerable head production, running the mower over a poorly grazed aftermath is not likely to lead to weevil destruction in an appreciable degree.

In order to correlate these observations with field conditions, about 4,000 heads of clover were taken from hay at different times, just before the hay was carted, and were carefully examined. Numbers of dead larvae and of living pupae were found, but no living larvae and only an occasional dead pupa. Heads were also taken from the rick about a month after it had been made, the sample being obtained from as far inside the rick as possible. Numerous dead larvae were taken from the heads, but no pupae. These observations show that haymaking under ordinary conditions results in *Apion* larvae being killed by dessication, but that neither haymaking nor stack conditions results in pupal mortality.

Degree of attack in seed growing districts.

An attempt was made to discover to what extent the Montgomery red clover seed crop suffers from *Apion* attack, visits being paid to twenty-five farms in the seed-producing districts in Montgomeryshire immediately before the crops were harvested, and a number of heads collected from each crop. The heads from each farm were bagged up separately and hung up to dry for three weeks. They were then carefully examined and a record made of all the insect fauna discovered. The degree of infestation varied considerably on the different farms, but since the chief object was to discover the state of affairs in the seed growing districts as a whole, Table VIII gives a summary only of the results obtained, and although a record was made of the whole insect population, the only particulars given here are of those species of *Apion* possessing flowerhead feeding larvae, namely *assimile*, *apricans*, and *trifolii.*

TABLE VIII.

Flowerheads collected from twenty-five farms in the seed producing districts in Montgomeryshire.

Total number of heads examined.	*Adults.*		*Pupae.*	*Larrae.*	*Total apion population.*
	Apricans and assimile.	*Trifolii.*			
5998	168	3864	8	64	4104

A preliminary examination of the Table shows that on the farms examined, the *Apion* population consists almost entirely of the species *trifolii*, and that when the heads were gathered, that is, immediately before the crop was harvested, practically the whole of the *Apion* population of the heads was in the pupal stage, and thus able to survive the dessication consequent to harvesting.

Further consideration of the data shows that the average number of *Apions* per head was 0.68, and assuming (see above) that each *Apion* larva destroys ten ovules, then under those conditions, 6.8 ovules in each flowerhead had been destroyed by *Apion* larvae. Williams (4) has shown that the average number of florets per head of Montgomery red clover is 140.3. Assuming each floret to be a potential seed producer, the average seed loss on the farms in question was therefore 4.9 per cent., and calculating on a yield of 3 cwts. per acre at a wholesale price of 1s. 6d. per lb, the average monetary loss on the farms was about 25s. per acre, a sum worth saving if possible.

Conclusions.

In the seed-growing districts of Montgomeryshire, the average monetary loss per acre caused by the depredations of the clover head *Apion spp.* is sufficient to justify attempts being made to reduce the *Apion* population in those districts, and more particularly on those farms which actually produce seed.

The destruction of larvae by dessication during the haymaking process offers an opportunity of obtaining maximum larval mortality by taking the hay cut at the optimum time.

With Montgomery red clover, anti-weevil operations cannot be carried out on the seed crop during the seed harvest year, but must be confined to the previous year or years.

When the clover is in the 25 per cent. full flower stage, egg laying has probably been completed, and the maximum number of the *Apion* population of the heads is in the egg or larval stage and therefore may be killed by dessication. The observations show that when the hay cut is taken at this stage the weevil population is large, and the percentage mortality high.

It is probable, therefore, that if the hay cut is taken when the crop is in 25 per cent. full flower, maximum larval mortality results.

No appreciable loss in total yield is caused by taking the hay cut at the 25 per cent. full flower stage.

It is possible for the clover seed growing farmers to obtain a great reduction of the *Apion* population of their farms by adopting the following practices :—

1. By taking all their hay cuts, whether of stands destined for seed production or not, when the clover is in 25 per cent. full flower, in preference to taking them at a later date in order to obtain an increase in yield, which is practically negligible.
2. By running the mower over all stands not destined for hay, if poor grazing has resulted in the production of a large number of flower heads. This to be done when the majority of the heads are in the 25 per cent. full flower stage.
3. In the event of a favourable season causing considerable head production in the aftermath, by using the mower in a similar manner.

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NOTES ON THE CALMETTE-GUERIN METHOD OF TUBERCULOSIS PREVENTION.

By **Norman Bisset**, M.R.C.V.S.,
University College, Cardiff.

It is impossible to over-estimate the importance of discovering a method of preventing the ravages of tuberculosis among stock. Many attempts to this end have been made by the employment of anti-sera, various chemical agents, tubercle bacillus toxin, etc., but none has given lasting results.

The writer has recently had the opportunity of studying what is perhaps the most successful method of prevention so far discovered, viz., the vaccination of calves with the B.C.G. (Bacillus of Calmette and Guerin), and the following is an attempt to describe the method as briefly and as non-technically as possible.

Before this method of control of tuberculosis in cattle came into operation the generally accepted method was that of Bang, viz., the application of the Tuberculin Test, and the destruction of reactors. This method of Bang is, however, only reliable in countries where the percentage of tubercular cattle is small. Where the percentage is large, it was proved by MM. Calmette and Guerin, of the Pasteur Institute, that there is a very great risk of affected animals being over-looked owing to the fact that, in a herd in which Bang's method has been applied, no account is taken of the calves, which have been exposed from the moment of birth, to tubercular infection.

These young animals, by licking themselves, take in virulent tubercle bacilli, which are absorbed through the intestinal wall, and find their way into the lymph glands, in which they lodge. It does not follow, however, that all such calves later on will exhibit the too well known signs of tuberculous infection, owing to variability in bodily resistance, numbers of tubercle bacilli taken into the system, and other causes. In fact, MM. Calmette and Guerin proved that it was possible for an animal definitely to recover from one single infection, even a comparatively massive one.

On the other hand, these animals are carriers of the germs, and it is important to remember that, so long as the latter confine themselves to the lymph glands, *the carriers may not react to the Tuberculin Test.*

If the bodily resistance of the animal is lowered—by illness, or after the first calving—the tubercle bacilli leave the glands, travel through the system, and set up the well-known lesions of tuberculosis in the internal organs. At this time the animal reacts to the Tuberculin Test.

Before this time, however, it is highly probable that many animals in the "Bang herd" have been infected from these supposedly healthy carriers, which may appear perfectly well for years and then, suddenly, without any warning, commence to discharge virulent tubercle bacilli in the dung and milk, especially the latter.

The Tuberculin Test, therefore, is by no means infallible, and the above brief summary will serve to show the difficulty of attempting to eradicate the disease solely by its means.

B.C.G. Vaccination.

It has already been mentioned that MM. Calmette and Guerin proved that it was possible for an animal to recover from a comparatively massive infection, provided that the infection was a single one. In this connection they discovered that the recovered animal was not susceptible to re-infection for a certain time, i.e., it was *vaccinated.*

They also found on the other hand that an animal which became infected several times in succession *never recovered.*

They decided, therefore, to vaccinate animals *as soon as possible after birth* with living tubercle bacilli which had been deprived of virulence, i.e., to introduce the harmless organisms into the system before the virulent ones could gain entrance.

It was, of course, essential that the organisms should be deprived of their virulence by a method which would not injure their properties of increasing the defensive agencies of the body against tuberculosis.

Without going into too great detail, it may be mentioned that such a method was finally discovered, viz., by growing the tubercle bacillus on special media consisting of potato slices specially prepared in ox bile. After 230 successive sub-cultivations on this media the germs entirely lost their virulence. The time taken for this desirable state of affairs to arrive was thirteen years. These non-virulent bacilli were designated the B.C.G., and their direct descendants are now used in the preparation of the vaccine.

Preparation of B.C.G. Vaccine.

The organisms are transferred from the bile-potato to special liquid media, on which they are grown for twenty-one days. They are then separated from the media by filtration and are finely ground up in a measured quantity of the same liquid media in a machine invented for the purpose by M. Guerin. The dose of bacilli per animal is 50 milligrammes, and it is administered in a volume of 10 c.c.

Administration of B.C.G. Vaccine.

It must be remembered that the vaccination is intended for the following animals :—

1. Calves born on a farm infected with tuberculosis, and for which infection is rapid and fatal.
2. Calves which, although born on a farm free from tuberculosis, may be subjected to occasional infection.

In both cases the calves should be vaccinated as soon as possible after birth, and, at latest, within the following fifteen days. If the farm is an infected one, it is necessary, besides, to preserve the calves for the whole of the month after birth from all risk of infection, whether from lodging or food, i.e., the calves should be removed from their mothers at the moment of birth, and if at all possible, they should be prevented from being allowed to drop on dirty floors or from becoming contaminated by tubercular discharges. Isolation should be thorough and complete. The young animals should be removed to entirely new premises and not simply separated from the others by a partition. Persons who attend to them should wear rubber boots, which should be regularly disinfected.

The isolated calves should be fed on milk from cows which have passed the Tuberculin Test. They should not be fed on boiled milk, which is liable to cause diarrhoea.

The vaccine is injected deeply into the dewlap, towards the upper third. No further care is necessary, but the animals should not be submitted to the Tuberculin Test. A small swelling will appear at the site of inoculation, about the size of the egg of a pigeon or hen. The swelling is quite painless, and disappears generally from the tenth to the fifteenth month after vaccination. It is claimed that the animal is protected from tuberculosis for as long as this swelling persists. Vaccination should, therefore, be carried out annually.

So confident of the efficacy of the vaccination are some of the workers in France that they have said to the writer that the time will come when the above mentioned swellings, indicative of the B.C.G. vaccination, will be recognised as hall-marks of freedom from tuberculosis, and that only animals showing the swellings will be considered by stock-owners.

In this country, however, the method is still considered to be in the experimental stage. Like all other new methods it has its opponents, and only time will tell which side is right, but, in the opinion of the writer, the results so far achieved in France by its means are sufficiently promising to warrant serious considerations by stock-owners.

THE POSITION WITH REGARD TO LIVER FLUKE IN SOUTH WALES.

By H. W. Thompson, M.Sc.,
University College, Cardiff.

Losses due to liver fluke occur every year in South Wales. Sheep are by far the worst sufferers but accounts of cattle losses due to this parasite are met with constantly also. On account of this persistent recurrence of the trouble each winter in one part of the area or another, the writer was led to pay some attention to the problem, and the following account is intended to summarise the results of observations made during the past five years on the subject. The ultimate aim of the investigation was to consider the possibilities of fluke prevention in the area. Enquiries made revealed the fact that many sheep farmers in the counties of Glamorgan and Monmouthshire were not familiar with the nature, mode of infestation, etc., of the fluke, nor of possible preventive or curative measures, and it has been the aim of the department at the University College, Cardiff, to place as much information on this subject as there is available before the farmers in the area. This has been done by means of lectures and the distribution of advisory leaflets to various branches of the Farmers' Union in districts subject to severe fluke attacks; by personal visits to "fluky" farms where requested and by demonstrations at selected centres of preventive measures, more particularly with regard to the application of copper sulphate dressings to the land as a means of eradicating the water snails which serve as intermediate hosts for the fluke.

The first stage considered desirable in the investigation was to map out as far as possible bad areas where fluke losses were of regular occurrence, and in this connection opportunities were taken to determine the general distribution of Limnaea truncatula, the water snail which serves as the fluke "carrier". The distribution of Limnaea pereger, another possible "carrier", has also received some attention, although so far, examination of a large number of snails has failed to show any young stages of the sheep fluke. During the present autumn and winter—in conjunction with the Zoology department—the work has been extended, and observations are also in progress on snails serving as intermediate hosts of other flukes. The additional species being studied are—Limnaea stagnalis, Limnaea palustris, Bithynia tentaculata, and also Paludestrina jenkinsi. This latter species has not been recorded so far as a fluke intermediate host, but its entry into this country is very recent, and since its introduction it has become distributed with such remarkable rapidity that it is to be found now almost everywhere in South Wales, usually in enormous numbers. Frequently streams on some of the worst " fluky " land contain this species in such numbers as to almost cover the bed of the stream or foliage of the vegetation present. On casual examination this snail may be easily mistaken for Limnaea truncatula, but closer examination shows a lid (operculum) which can close up the entrance to the shell when the snail retracts. This operculum is not present in Limnaea truncatula. In view of this universal distribution in the area some attention is being paid to Paludestrina jenkinsi.

The general position in Glamorgan and Monmouthshire with regard to sheep keeping and the occurrence of liver fluke is given below, together with a brief summary of other factors present in the area which may have some bearing on fluke incidence or problems of control.

Glamorgan may be briefly described as a coastal plain area, bounded northwards by mountain ranges which may in places reach a height of nearly 2,000 feet and of an average height of about 900 feet. Monmouthshire is somewhat similar, although the change from plain to mountain area is much less sudden and the whole centre of the county is of a very undulating character, broken at the eastern boundary by the valley of the Wye and near the western boundary by the Usk valley.

In Glamorgan, the coastal part with the Cowbridge-Bridgend area as centre forms the very fertile Vale of Glamorgan, and in this region flocks of Downs sheep are kept in places, although crosses—more particularly with Welsh Mountain or Kerry Hill breeds—are more common. The mountain regions in the northern part of the county are suitable for sheep rearing in many parts, and here little else except Welsh Mountain sheep are to be found. This breed, although small in size, is noted for the quality of its mutton and possesses the necessary hardiness for the exposed districts. Taking the sheep of the area as a whole, the Welsh Mountain breed predominates, with Kerry Hill's a bad second, whilst the most popular cross for the lowland districts appears to be a Welsh Mountain-Suffolk cross. Ryeland sheep are popular in some districts.

Monmouthshire is very similar to Glamorgan with regard to breeds of sheep kept, although with a lesser proportion of Mountain rather fewer pure Welsh Mountain sheep are found, and apparently more of the Radnor breed and Radnor crosses are present than in Glamorgan. The Suffolk cross is again popular.

The rainfall of South Wales may be regarded as excessive, although it is exceeded by some of the North of England Counties, notably in the Lake District. The average rainfall for the area is in the region of 70-75 inches per annum, which is more than double that of some of the eastern English Counties. South Wales is noted for its mild wet winters. Snow seldom lies in the area.

Such conditions—heavy rainfall and mild winters—are, unfortunately, favourable for the development of the snails which serve as intermediate hosts for the liver fluke parasite which is normally very prevalent, and is widely distributed in the area. Many low-lying, flat parts of the counties are almost impossible to drain, and with the heavy local rainfall these areas are marshy and form ideal breeding places for the snails. In the mountain regions, where the rainfall is much higher still, springs abound in places on the hill slopes and in the valleys, and here, also, these snails are frequently very numerous.

So-called " moors " occupy quite a large area in the two counties. The term " moor " is locally applied to flat, marshy, frequently low-lying areas, usually rushy in character. Elsewhere the term is usually given to a high-lying tableland, more or less heather or bracken covered, and peaty in character. Unfortunately the South Wales moors, owing to their swampy nature, are frequently very " fluky ", and in bad years give rise to considerable sheep losses, which is what the prevalence of Limnaea truncatula would lead one to expect. Similarly, in many of the mountain regions, the snails are numerous and losses are frequently heavy also. Altitude alone, apparently, is not sufficient to remove the danger of infestation. Cases have been met with, as on Caerphilly Mountain, where at an altitude of 900 feet above sea level, the snails were very numerous and losses due to fluke of annual occurrence.

Comparatively small annual losses frequently turn (following a wet summer) into a very serious epidemic, and in some parts of Glamorgan and Monmouthshire (as in the winter of 1927-28), losses on certain farms may reach 70-80% of the sheep carried.

In the Vale of Glamorgan, sheep management is undoubtedly of a very high order, but in spite of this losses in this part of the county are frequently high. Little (1) records very serious losses in 1879 and abnormal losses have also been noted in subsequent wet seasons, such as 1900, and losses lighter in character occur every year. The general opinion appears to be that the parasite has made headway during comparatively recent times. Apparently it was at one time the custom in the two counties as a whole to keep more or less regular breeding flocks, whereas now the principle of drafting in fresh ewes during the autumn is almost universally followed. Very many farmers in the area will not run the risk of keeping sheep for a second winter.

The purchase of fresh ewes each autumn, usually from Mid-Wales, introduces the difficulty of being certain that ewes are sound at the time of purchase. It is highly probable that in the main ewes from this source are comparatively free from fluke, although cases have come to notice where this was far from being the case. On one farm in Central Glamorgan ewes purchased in this way in the autumn of 1927 were so heavily infested that deaths due to fluke commenced within a week of purchase, when they appeared quite sound.

The difficulty in being certain of buying sound sheep is accentuated by the fact that for some time after the animal has picked up the parasite it may thrive particularly well and may show no outward sign of infestation, only to fall off very rapidly afterwards. In epidemic years when particularly heavy infestations occur, the number of young flukes reaching the liver may be so heavy as to kill the animal within a few weeks. In this case the typical signs by which affected sheep may be recognised—such as " fluky " eye, rapid falling off in condition, swellings under the jaw, etc.—may not appear. The case referred to above was of this type. The sheep died off in big numbers in October and November, when many of the flukes were only about a quarter or half grown, at which stage they were too young to be destroyed by the Male Fern Extract used in the district.

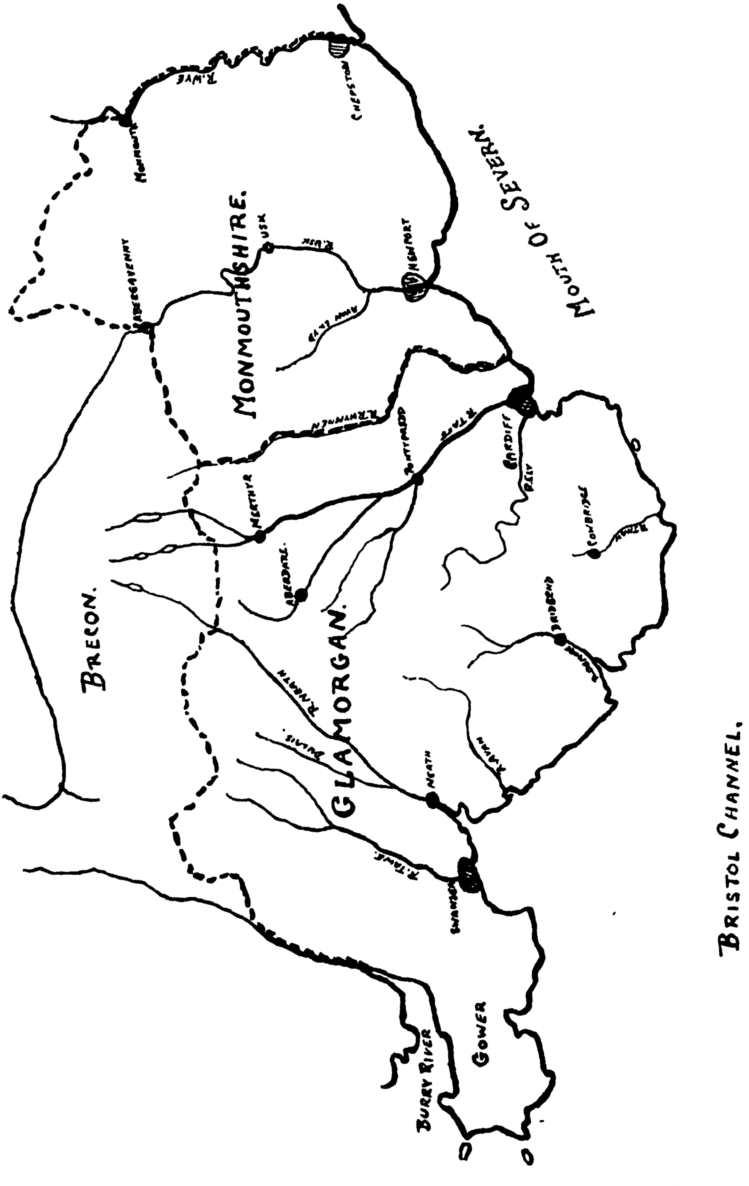
Undoubtedly very many farmers realise the importance of purchasing sheep from a source they know from experience to be reliable, and regularly buy from the same district or even farm. Cases such as the above emphasise the importance of the more general adoption of this principle. It is not sufficiently clearly recognised perhaps by farmers that it was the ground the sheep were on two or three months before the symptoms appeared which was of importance. The land on which the sheep are at the moment is often wrongly blamed for the trouble.

Examination in the laboratory of a large number of snails of the species Limnaea truncatula appears to show that the bulk of the parasites have left the snail by the end of October or early November. No stages earlier than the cercaria producing redia stage was to be found in the snails examined after the end of August in 1928, and very many free cercariae were found at this time, which suggests that in this season at any rate September and October were the months when most cysts were ready for being taken up by the sheep.

Records have been compiled as accurately as possible during the years 1924-28 of the occurrence of Limnaea truncatula and Limnaea pereger in Glamorgan and Monmouthshire. Naturally, these records are very far from being complete, but enough records of occurrence have been made to give a good idea of their general distribution in the area. The distribution of the snails is undoubtedly very general. Limnaea truncatula has been met with from sea level up to the 1,000 foot mark. It is more prevalent in Glamorgan than in Monmouthshire. Obviously, in bad fluke years the snail is sufficiently well distributed to make very large areas liable to fluke infestation. This has been found to be the case during years when bad epidemics have occurred. Even in the Vale of Glamorgan, in parts where little trouble is usually experienced, this host snail was to be found at certain times during the winter of 1927-28 (a bad season), in almost every wayside ditch and stream.

Consideration of South Wales in rather more detail from the standpoint of snail occurrence and fluke infestation, and commencing at the western end of Glamorgan has yielded the following main facts. The map appended will indicate the areas referred to. The peninsula of Gower has districts where the dangerous snails are plentiful and where fluke troubles occur with something approaching regularity. On the north coast the salt marshes have not been found to harbour Limnaea truncatula, although a belt fringing the marshes above the brackish water-zone contains them in numbers, whilst the Gowerton district is also particularly suitable as a breeding place for the snails. The central and southern parts of the peninsula appear to be comparatively clear. About much of the mountainous country north of Swansea no information is available up to the present, but the Swansea, Neath and Dulais Valleys have areas particularly liable to infestation. Other areas where Limnaea truncatula is very common are the moorlands above Maesteg, Margam Moors, Hirwaun Common, Cowbridge Moors, and the Tonyrefail and Llantwit Fardre districts south of Pontypridd. The districts mentioned are the ones where snail infestations are particularly heavy, but in many other districts lesser areas or even isolated farms are heavily infested and liable to periodic fluke outbreaks.

In Monmouthshire the position with regard to these snail infestations and fluke appears to be rather more happy. Apart from the land flanking the Severn, where much of the ground is too wet for sheep, such as the Wentloog level between Cardiff and Newport, and the Caldicott level between Newport and Chepstow, there appear to be no particularly bad areas until the northern parts of the county adjoining Brecon and Hereford are reached, although there are a number of small areas, in the Avon Lwyd Valley in particular, where heavy sheep losses are liable to occur. On the levels mentioned, Limnaea pereger is particularly plentiful,



Sketch Map of Glamorgan and Monmouthshire.

the semi-stagnant dykes found in these areas, often heavily overgrown with vegetation, suiting this species as a breeding place. Above these levels, where the ground is rather better drained, but where springs and slow running streams are plentiful

Limnaea truncatula is common, and this species is to be found in places right up through the centre of Monmouthshire, being particularly plentiful between Usk and Raglan on Trostrey Common.

A number of points emerge after study of the distribution of these water snails in South Wales. The first is their wide distribution in the area. Another is that certain types of wet land do not favour the snails. On some land which has been known apparently for generations as "rotten" land, the snails are not to be found. Especially is this the case on the more sour and peaty marshes, though frequently a belt surrounding such an area is found to contain snails in large numbers. Streams are less liable to contain the species L. truncatula than damp ditches and springy areas. Fast running streams are as a rule clear.

In many parts of the country rabbits are considered to be dangerous, as being likely to keep the fluke parasite going on ground temporarily free from sheep. This danger does not occur on many of the "fluky" areas in South Wales which adjoin mining areas where rabbits are never numerous, largely owing to the sporting activities of the residents of the district.

Cases have been recorded in the area which seem to indicate that rough grass is safer to run sheep on than finer herbage when snails and apparently the risk of infestation are approximately equal. This is rather what would be expected, as the parasite cysts are usually to be found low down on the grasses.

The practice of dosing the sheep on "fluky" farms in South Wales is extending, the drug most commonly used being Extract of Male Fern, and its use has undoubtedly proved satisfactory in a large number of cases. Proprietary brands of Carbon tetrachloride advocated by Dr. Montgomerie (2) have been tried by farmers in a number of places and have given satisfaction to the users. In addition to this, copper sulphate dressings applied to pasture land for the elimination of Limnaea truncatula, the intermediate fluke host, have been tried in a number of areas. Demonstrations of this treatment have been given to farmers in many of the "fluky" areas by the Adviser in Agricultural Zoology. In the main these applications have followed the lines found so satisfactory for this purpose by Walton in North Wales (3), the dressing now used being about 20 lb. of ground sulphate of copper and ½ cwt. of fine silver sand per acre. Obtaining satisfactory dry sea sand often proved to be a problem, hence silver sand, which can be obtained from the same source as the copper sulphate, was substituted. Dressings at the above rate have proved quite satisfactory, kills of up to 90% of the snails present having been obtained. The use of Kaolin and the application of copper sulphate as a wet spray have been discontinued as being less generally applicable than the mixture mentioned above. It is generally found that even on bad farms where fluke is a serious problem, the " dangerous " ground is often limited to two or three acres, and it is on farms such as this where " bluestone " dressings to the ground are most practicable, and its use attended with the best results.

Observations so far made on the possibility of fluke prevention in the area emphasise the following points :—

1. The importance of spreading information on control methods. The value of drainage and clearing of ditches is often not clearly recognised. Open drains costing little could be made much more use of than is the case at present. The general application of the proved methods of prevention and control of liver fluke now known would go very far towards the reduction of losses due to this parasite in South Wales, even although such large areas occur where efficient drainage is almost an impossibility.

2. Purchase of sheep from what is known to be a safe source should be followed in all possible cases.

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ABSTRACTS, REVIEWS, AND BIBLIOGRAPHICAL NOTES.

AGRICULTURAL ECONOMICS.

Abstractors:

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Economic Conditions in Welsh Agriculture.—Suggestions for some Remedies.

A. W. ASHBY, M.A., Agricultural Economics Department, University College, Aberystwyth, 1928.

This is the first attempt to analyse systematically the economic aspects of the industry in Wales. The author fully realises and acknowledges " the strength and the excellence " of Welsh farming, but a study that attempts to analyse critically any system of farming should also adequately deal with the weaknesses. This study not only indicates weaknesses but attempts to show the lines upon which improvement could be made.

In Part I the author treats of the " General Position in Agriculture " since the war and points out that " steady prices even at a low level are better than changing ones ". The prices of agricultural requirements are dealt with in detail; to mention only one of these, but undoubtedly the most important—labour costs—the author is of opinion that economies in this department should be in the nature of more productive utilization of labour and not effected through reduction of wages. The summary of Part I emphasises the importance of the " lag " between expenditure and receipts which is more common to agriculture than other industries.

Part II, " Conditions on the Farm ", is divided into two sections—the " Utilization of land " and " Livestock Production ". The fall in cereal production in Welsh farms is noted and a suggestion is made that this reduction in arable acreage should be reconsidered. " They (Welsh farmers) should have regard not only to the general prices for cereals in their own selling markets, but to costs of concentrates in substitution of home grown cereals on their own farms . . . " In view of the fact that the percentage arable to total cultivated arable in Wales in 1927 was below 25 per cent., Mr. Ashby's paragraph on " Grassland Management " is indeed suggestive and timely. Again the suggestions that where possible mangolds should be increasingly grown and not swedes and turnips and that kale and rape on poorer soils should be given more trial is worthy of serious consideration by most of the Welsh upland farmers.

Livestock production, speaking generally, is the chief source of income to the Welsh farmer and the author, although limited by time and space, gives a great deal of attention to this question. The changes in the cattle and sheep markets have been rapid during the last twenty years and naturally have given rise to complications. The author points out that to-day only 36 per cent. fat beasts are ready for market in the first half of the year, whilst before the war 53 per cent. went to the market. To overcome the drop in prices which occurs when the greater part of the Welsh supply is ready, the suggestion that a combination of more winter fattening, a little more arable cultivation—this is essential or the costs of fattening with bought foods would quickly neutralise any benefits that may accrue, and better regulation as between winter and spring supplies demands attention.

The paragraphs devoted to " Dairy Herd Management " clearly indicate the various types of herd management in Wales. There is one suggestion here which should and must be considered and acted upon by the Welsh farmer if he hopes to sell his stores profitably. The demand for younger and more forward stores in the grazing districts of England is increasing and the Welsh rearer must produce more autumn and winter calves. It appears that milk production has been fairly satisfactory in Wales, but, as the author points out, a variation between 7d. and 15.3d. per gallon in milk costs suggest the diverse conditions under which milk is produced.

Sheep on hundreds of Welsh farms are practically the sole means of the farmers' livelihood and one readily agrees with Mr. Ashby that had they made the same strides in beef production and marketing as they have in the case of sheep their position would be considerably better. The suggestion that less " breeds " should be used for crossing purposes is one that should be considered in view of the many preferences found amongst sheep breeders. This applies possibly more to the effect on the wool than on the mutton in the case of the ewes being of the native breed.

Pigs and poultry conclude the chapter on livestock. The " cycle " in pig prices and production is dealt with and it is maintained that with better information fluctuations in production and prices could be lessened.

Part III deals with marketing problems and emphasises the point that there is need for more knowledge of conditions and methods of marketing.

The study concludes with an Appendix on " Labour Organisation on Welsh Farms ", by Mr. J. Ll. Davies, which serves to illustrate some of the points raised by Mr. Ashby; and a further Appendix on the transactions of twenty-three and twenty-eight dairy herds for the years 1925-26 and 1926-27. A.J.

ACCOUNTS AND COSTS.

Farming Costs and Financial Results; Reports on.

(8) The Cost of Horse Labour (with Notes on Tractor Costs).
(5) Poultry Keeping Costs and Financial Results for four years.
(6) Corn Growing. Cost of Production and Financial Results.

By JAMES WYLLIE, B.Sc., South Eastern Agricultural College.

Report 3 discusses the cost of horse labour on a number of Michaelmas and Lady Day farms for the three years 1923-27. The average net cost per horse per annum on the Michaelmas farms was almost £38, while on the Lady Day farms it was £35 10s. The average cost per horse per week was 14s. 7d. on the Michaelmas and 13s. 8d. on the Lady Day farms. In general, it may be stated that on these farms the " average " horse worked from thirty-three to thirty-four hours each week at a cost of from 5d. to 5¼d. per hour, 13s. 9d. to 14s. 10d. per week, or £85 15s. to £37 14s. per annum. There are tabular statements in the report showing in detail the cost items of depreciation charges, the relative importance of different items in the cost of horse labour, the average quantities of foods consumed per horse per annum and the variations of cost of horse labour from farm to farm. The author is of the opinion "that the relative importance of horse labour as a factor in determining the financial results in farming is very commonly exaggerated and that it is extremely difficult to obtain statistical evidence that will show at all definitely where economies can be effected in connection with horse labour".

A summary of tractor costs is given in an appendix at the end of the report.

Report 5 deals with the financial results from poultry keeping on fourteen farms during the period 1923-24 to 1926-27. All the farms carry on a more or less mixed system of farming and no specialised poultry farms are included. For comparative purposes the farms are divided into two classes—those on which poultry are kept on fairly large scale (commercial system), and those on which poultry are regarded as a comparatively small side line ("barn door" system). For the farms classified under the "commercial" system one holding with an average of about 900 head of poultry showed a profit of £1,585 in the four years, another with about 660 head of poultry realised a profit of £484, while a third with 650 head showed a loss of £21. Nine of the farms under the "barn door" system realised an average profit of approximately £22 per farm per annum, the average head of poultry being about 160. On one farm with about 130 head a loss was shown of £153 in four years. The summary of the costs indicate that about three-fifths of the cost of egg production consists of food, one-fifth of labour, and one fifth of other items. On farms where about 80 per cent. of the total revenue comes from sales of eggs, the quantity of poultry foods (grain and meals) used per dozen eggs sold is approximately between 11 and 11½ lbs.

Report 6 deals with the costs of production and financial results for wheat, barley, oats, beans, peas and mixed corn, on nineteen farms in the counties of Kent, Surrey, East Sussex, and West Sussex, for the harvest years of 1924, 1925, and 1926.

Omitting interest on capital or managerial salary, the total profits from 1,057¾ acres of corn in 1924 was £2,091 16s. 11d., or £1 19s. 7d. per acre. A total profit of £394 15s. 7d., or 7s. 7d. per acre, was obtained from 1,043¾ acres in 1925, while a total loss of £765 10s. 4d., or 13s. 2d. per acre, was shown for 1,162 acres in 1926. The barley crop showed a profit for the three years under review, and the wheat crop for the harvest years 1924 and 1925, while the oats, beans, and peas showed a loss in each year. The author attributes the decline in the profits from corn growing during 1924-1926 to the increased costs per acre and a reduction in the selling price. In the case of the 1926 wheat crop the low yield was also a contributory factor.

A summary of the cost of production of the various crops (excluding interest on capital or managerial salary) is given below:—

	Wheat.			*Barley.*			*Oats.*			*Beans.*			*Peas.*		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1924	12	0	1	11	7	0	12	1	11	14	11	6	15	10	10
1925	12	5	11	12	6	4	11	6	0	14	10	1	13	10	10
1926	18	1	2	12	14	11	13	0	7	16	14	8	16	4	9

After giving credit for the straw, the average costs of production per cwt. of grain were as follows:—

	Wheat.	*Barley.*	*Oats.*	*Beans.*	*Peas.*
	s. d.	s. d.	s. d.	s. d.	s. d.
1924	10 0	8 4	11 0	16 7	15 9
1925	10 2	9 10	11 2	18 5	16 7
1926	12 7	9 5	12 0	26 5	18 6

The average selling prices of the grain were as follow:—

	Wheat.	*Barley.*	*Oats.*	*Beans.*	*Peas.*
	s. d.	s. d.	s. d.	s. d.	s. d.
1924	18 1	15 7	10 6	12 8	10 8
1925	12 1	11 11	10 2	11 0	12 3
1926	12 2	12 8	8 11	9 8	12 0

In discussing the outlook, the author thinks that very little reduction can be effected in the cost of seed, general stores, farmyard manure, equipment and thresher hire, and that the most definite saving in the cost per acre to which one can look forward to is in the local rates. This may on an average amount to a reduction in the costs of 5s. per acre. As regards the costs of labour, further investigation seems to be called for. Could the cultivator and disc harrow not be more widely used after the first ploughing, especially where a tractor is available? Is it necessary to plough at all for wheat after potatoes? Is the method of building corn stacks sound? Could a definite saving be effected by a greater use of Dutch barns? It is suggested that such questions the farmer himself might try to answer with benefit to practice.

These are three very useful reports for those interested in the financial side of farming. J.P.H.

Farm Profits and Farm Losses.

By Arthur G. Ruston and O. Anderson, Department of Agriculture, University of Leeds.

This report gives the analysis of six years' financial records of a number of farms in Yorkshire, and the authors endeavour to trace the factors that account for profit and loss in farming. Below is given a summary of the gross results:—

Period.	*No. of Farms.*	*Gross result.*	*Per acre.*	*In terms rental.*	*As % of Capital invested.*
			£ s. d.		
1921-22	38	Loss	2 10 6	1.82	17.7
1922-23	55	Loss	1 8 4	1.16	10.9
1923-24	70	Profit	0 8 11	0.3	3.4
1924-25	88	Profit	0 10 7	0.4	4.0
1925-26	80	Profit	0 5 8	0.3	2.4
1926-27	77	Profit	0 7 8	0.33	3.3

From the above table it will be seen that in no case during the six years has the " average farm " of these groups left a financial return equivalent to that obtainable had the working capital sunk in the holding been invested in ordinary trustee stock.

The returns for the individual farms show widely varying results. In the last year (1926-27) they vary from a loss of 82 per cent. to a profit of 49 per cent. on the working capital invested. The financial records show that there are some co-relations between the size of farms, geological formation, and geographical position, etc., and the results obtained. The authors, however, consider these of minor importance and stress the fact that the really big and dominating factor is the personal one. Several examples of successful and unsuccessful farming are quoted in order to emphasise this point.

The records show that the crops have left a total profit of £37,411, and the livestock a total loss of £41,543. The losses in the livestock section were attributed to cattle and horses. Cows made the biggest profits. Where a breeding flock of sheep has been kept and the lambs got off early, the sheep have, as a rule, left quite a reasonable return. Poultry have each year given a satisfactory return and last year an average profit of 4s. 6d. per laying hen was obtained.

While in agriculture, as in every other business, there is no royal road to success, the authors, from a study of the records of successful farmers, state that there are at least three essentials of success.

1. There must be a high output or production.
2. That high output must be produced at low production cost and with minimum capital outlay.
3. That which has been produced in large quantities cheaply must be disposed of to the best advantage.

There are important sections in the report that cannot be conveniently summarised and it can be recommended as an interesting publication which will repay careful study. J.P.H.

Fourteen years successful Poultry Farming.

By Arthur G. Ruston, B.A., D.Sc., and C. V. Dawe, M.Com., Department of Agriculture, University of Leeds.

A report which should prove useful to poultry keepers and poultry instructors. It describes the development of a successful poultry farm which started in 1913 with twelve laying birds. The total outlay of £2 2s. for the birds and £5 for equipment laid the foundation of the present flock, which from a trading account given in the report, left in 1926 a profit of £667. Tables showing the capital invested in livestock and in equipment and the net profit, the average number of laying birds of different ages, the sales of poultry and eggs, and the production costs per bird and per dozen eggs for each year, 1913 to 1926, are given. The policy adopted in building up the flock and the method of financing the undertaking is commented upon. J.P.H.

Milk: The Economics of its Production and Disposal.

By Arthur G. Ruston, D.Sc., Department of Agriculture, University of Leeds.

A study of a number of Yorkshire farm records reveal the fact that, taken as a whole, milk cows have left each year a good financial return, such is especially the case when the produce is marketed in the form of liquid milk. From a table given in the report it is shown that for thirty-one herds during the period 1923-24 a total of 378,302 gallons of milk was produced at 1s. 2½d. per gallon. The average yearly cost of keeping a cow amounted to £35 0s. 4d., or 13s. 6d. per week. Of this total cost, the food bill represented 66 per cent., the labour bill 26 per cent., and the depreciation on the cows 8½ per cent. Each cow on an average had the grazing of approximately 1½ acres of pasture and in addition consumed about 2 tons of hay and straw, 4½ tons of roots, and 1 ton of concentrated foods. The receipts amounted to £42 4s. 10d. per cow, or 1s. 5½d. per gallon of milk. The profit per cow per year was £7 4s. 6d., or 2¾d. per gallon of milk produced. Of the returns, 77 per cent. came from the sale of wholesale and 18 per cent. from the sale of retail milk. Household, calves, and butter accounted for 5 per cent.

Tabular statements showing the average yearly variations in the cost of upkeep per cow, and returns, for a number of Yorkshire farms for the years 1919-20 to 1926-27 are given. The report should prove useful to those interested in the economy of milk production. J.P.H.

Sugar Beet in the Eastern Counties.

Report No. 9, by R. Mc. G. Carslaw, C. Burgess, and G. Ll. Rogers.

An Economic and Financial Analysis. East Anglian Farms.

Reports Nos. 10 and 11, by R. Mc. G. Carslaw and W. H. Kirkpatrick,

Farm Economics Branch, Cambridge School of Agriculture.

Report No. 9 deals exclusively with sugar beet and gives the results of an investigation carried out in 1927 on 100 farms in the Eastern Counties, covering a total area of 42,298 acres.

The farms are distributed throughout Norfolk, Suffolk, Essex, Hertfordshire, Cambridgeshire, Bedfordshire, the Isle of Ely, the Soke of Peterborough, and the three divisions of Lincolnshire. The total area of beet grown on the 100 holdings was 3,700 acres.

Some of the most important features emerging from this report are pointed out by Mr. J. A. Venn in the Foreword. Attention is drawn to Table 12, which gives the average gross and net over-all profits. The average cash profits on the 100 farms was only 5s. 5½d. per acre and 8½d. per ton of washed beet. When an allowance is made for the value of the tops and cultivation and manurial residues a net profit of £4 4s. 1d. per acre, or 10s. 10¾d. per washed ton, is shown. This emphasises the value of the crop to the grower apart from its actual cash profit. Other portions of the work deal with the relationship between the size of the fields and the cost of production per acre; the financial results of using fertilisers; and the large scale investigation into the effects of varying dates and rates of drilling seed.

The report contains thirty-three tables and eight appendices. It has been prepared with great care and thoroughness and should be studied by those interested in this recent development in agriculture.

Report 10 deals with the financial analysis of fifteen farms (Michaelmas) 1926-27 and the results for ten of these are dealt with for the fourth year. Report 11 gives the results of five farms (Lady Day) 1927-28, four of which are reviewed for the fourth year in succession. On the fifteen Michaelmas farms the results show that the average net profit is represented by 0.9 per cent. on the capital invested, which is equivalent to 8s. 5d. per acre. When an allowance is made for interest on capital and the value of unpaid labour, the profit is reduced to a "loss" of 8.4 per cent. The five Lady Day farms show a net loss of 3.7 per cent., or 8s. 3½d. per acre. If interest on capital is charged at 5 per cent., and unpaid managerial work is assessed at £200 per annum, the "loss" is increased to 9.8 per cent. It is stated that the financial results for the farms under review were the most disappointing of all the years covered by these enquiries. The reports contain much valuable information dealing with the cost of manual and horse labour, and crops, together with various other economic and financial data. J.P.H.

(a) Sugar Beet: Cost and Returns, 1926–27.

(b) Sugar Beet: Cost and Returns, 1927–28. (Provisional figures).

By A. Bridges and J. R. Lee, Agricultural Economics Research Institute, Oxford.

The first of these reports discusses the costs of and returns from growing sugar beet on 270 farms for the year 1926-27. The total area of beet grown was 2,177 acres, and the holdings were distributed over the most important beet growing districts in England. An average cash profit of £7 4s. 8d. per acre was realised for all the farms. Judged on a tonnage basis, the returns were 14s. 2d. per ton on an average yield of 10.19 tons of washed beet per acre. From the individual costs it is seen that 25 per cent. of the farms failed to realise cash profit. When, however, deductions are made for the value of manurial residues and cultivation, about 9 per cent. of the farms show losses and the average profit on the assessed value of residues becomes £10 2s. 2d. per acre, or 19s. 10d. per ton. Comparisons are also made of the costs and returns on a soil group basis, and these are herewith summarised:—

	Light soils.	*Medium to heavy soils.*	*Heavy soils.*
Per acre.	£ s. d.	£ s. d.	£ s. d.
Cash profit ...	8 9 3	6 18 11	5 10 9
Presumed real profit* ...	11 6 1	9 12 0	8 7 6
Yield. Tons ...	9.74	10.58	9.92
Cash profit per ton ...	17/5	12/8	11/8
Presumed real profit per ton*	23/2	18/1	16/11

The second report provides a short preliminary statement of certain provisional averages for the year 1927-28. The number of costs reviewed is 143, covering 5,574 acres in nine districts in England and Wales. Owing to the effect of an unfavourable season, the results for 1927 were very disappointing, and only two of the nine districts showed an average cash profit. The yield was low and only averaged 7.73 tons of washed beet per acre. The average cash profit was 8s. 9d. per acre, or 1s. 1d. per ton, or £2 12s. 1d. per acre, or 6s. 9d. per ton after allowing for residues of cultivation and manures. Soil group costs are included in the statement and a table is given showing the financial results of all the crops obtained over the last four years. These are valuable reports in that they give the results of the cost and returns of sugar beet in several districts throughout England and Wales. J.P.H.

**Editor's Note.*—Subject to realisation of estimated values of tops and of residual values of manures and cultivations in subsequent processes and in sales of crops and stock.

Sugar Beet in France, Belgium, Holland, and Germany.

A. Bridges and R. N. Dixey, pp. 118. Clarendon Press, 1928.

This book contains an account of the sugar beet crop in France, Belgium, Holland and Germany and is the result of three visits paid by the writers to the principal beet growing areas in those countries in the years 1926 and 1927. The introductory part gives a brief description of the crop, the soils, size of holdings, rotation and cropping, livestock and labour in the sugar beet areas visited. Other chapters in the publication deal with seed, manuring, sowing and summer cultivation, harvesting, yield, by-products, costs and returns, transport, reception of beet at factories, price fixing and the effect of sugar beet on agriculture. Appendix I contains a form of contract in use in Belgium between a factory joint stock company and its growers.

The writers in their concluding statement attribute the prosperity of the sugar beet industry on the Continent to several factors: Cheap and efficient casual labour is obtainable; and there is the peasant proprietor with his industrious habits and frugal standard of living. The utilisation of the by-products is also an important factor. In some districts where fodder crops cannot be easily cultivated, the beet crop owes its existence in no small measure to the full use that can be made of the tops and leaves and of the pulp. Every endeavour is made to increase the value of this side of the business. Again, there is the high yield and this is to an appreciable extent due to the suitability of the soils for beet growing. On the marketing side it is probable that the Continental grower is more assured of obtaining the right price than the grower in this country. Prices can be adjusted to varying local conditions and the Continental grower usually shares in the varying prosperity of the industry either by means of co-operative principles or as a shareholder in the factory company. Co-operative methods have proved very successful and in one country co-operators now hold a large portion of the field previously held by joint stock enterprise.

While attention has been drawn throughout the report to salient features of Continental practice and experience which might benefit the British beet grower, it is emphasised by the writers that no Continental practice should be adopted in this country except after careful trial under conditions of British soils, climate, and above all of labour.

The book contains several interesting photographs and diagrams. The facts and ideas are presented in an attractive form and the authors are to be congratulated on the publication of a very useful report on the Continental methods and practices of sugar beet growing. J.P.H.

ECONOMIC THEORY.

The Incidence of Taxation in Agriculture.

J. A. Venn. *Economic Journal*, Vol. 38, No. 152. December, 1928.

This is the substance of an address to a Joint Meeting of Sections F and M at the British Association, 1928. It deals with rates, tithes, land tax, and income tax. A careful review of figures indicates that the proportion of rates in the total production expenditure of farms lies between 1½ and 2 per cent., or in the neighbourhood of 1.6 or 1.8 per cent. There are indications that the " burden " of rates was falling from 1840 to 1890, and of a subsequent increase. In 1919, on the average, rates lay between 2s. 6d. and 8s. per acre, and in 1927-28 amounted to about 8s. 2½d. The recent contribution in rates has represented about £18 13s. " per farmer ". Rates is legally a tenant's charge in England and Wales. Tithe payments in 1914 represented about 2s. 1d. per acre; and more recently amounted to 2s. 6d. per acre, or with " redeemed " tithe to 3s. 1½d. Tithe is legally an owner's charge. Land tax amounts to less than 6d. an acre, or £2 " per farmer "; it cannot exceed 1s. per acre. This is an owner's charge. Between 1914 and 1927 the total of rates, tithe, and land tax per acre rose about 26½ per cent., but the tenant's " burden " of rates rose 88-89 per cent. Income tax, as far as information is available, amounts on the average to about £5 " per farmer ". With the existing methods of deduction and allowances every married man farming land up to about 150 acres is totally exempt and possession of even a small family carries exemption up to 300 acres. " Neither the tenant farmer nor the occupier-owner of less than 500 acres is entitled to regard income tax as a " burden ".

While, in strict economic parlance, this study deals only in a minor way with the vexed question of " incidence " and more with the weight of " impact " of taxation, it is of very useful character; and as the weight of impact is being reduced there is less necessity for the study of incidence.

A.W.A.

FARM POWER.

Electricity Commission. Report of Proceedings of Conference on Electrical Suppply in Rural Areas.

H.M. Stationery Office, London. 1928.

The Conference was convened by the Electricity Commissioners under the presidency of Sir Harry Haward. The first meeting was held on the 22nd November, 1927. Two subsequent meetings were held on the 18th March and 26th June, 1928. At the first meeting two Sub-Committees were formed to investigate and report on the following aspects of Rural Electrification :—

1. The nature and extent of the potential demand for electricity in rural areas.
2. The bearing and general effect upon rural development of the price of supply and the cost of electrical equipment.

In addition, the question of publicity and propaganda was remitted to the British Electrical Development Association for consideration and report.

The Reports submitted by these bodies are reproduced as part of this publication.

Nature and Extent of Potential Demand.

Statistics for the present supply of 669 townships and villages in rural areas, involving a population of over 1,400,000, in Great Britain are reviewed.

Where a supply has been established for three to four years, consumption varies from 16 to 20 units per head of population. It is pointed out that a consumption of 60 units should be attained in the most promising areas three to four years after commencement of supply.

The number of farms connected to public supply mains in Great Britain at the end of 1927 was 1,770. On 1,473 farms there was an average consumption of 1,150 units.

The character of the rural demand is similar to the existing urban demand and there is much scope for the extension of the use of electricity for power purposes in rural areas.

The relation of the forecasting of demand to future development is treated, and such questions as price of supply and equipment. Other questions treated are: the relation between revenue and capital expenditure; cost of alternative facilities; limits of price; tariffs; wiring and apparatus; publicity and propaganda.

The Reports were adopted by the Conference, and thirteen recommendations were made in respect of the future development of rural electrification. The Reports of the two Sub-committees and of the British Electrical Development Association are appended in a summary form, and the Report furnishes a valuable and comprehensive summary of the position in relation to rural electrification in Great Britain. T.L.

FARM SURVEY.

Grass Farming in the Welland Valley, pp. 66.

J. LLEFELYS DAVIES, Agricultural Economics Research Institute, Oxford, 1928.

This study was undertaken to collect information regarding the systems of farm management obtaining in one of the best pasture areas in the British Isles, to serve as a basis for any specific investigation of the graziers' problem as a whole. The area surveyed is usually known as the "Harborough" country. The holdings for which detailed information is given are divided into three groups:—up to 150 acres, average 80 acres; 150–300 acres, average 197 acres; 300 acres and over, average 488 acres. Each of these three size groups is sub-divided into "grazing", "dairying", and "mixed" farms. The proportion of arable throughout is quite small, averaging 6 per cent. for the whole of the groups, but rising to 27 per cent. in the "mixed" sub-group of the second size group. The proportions of pasturage according to quality over the whole groups are given as 42 per cent. first class, 32 per cent. second class, 26 per cent. third class. The proportion for hay was only 16 per cent. of the total permanent grass. Of the small acreage of arable, 65 per cent. was devoted to cereals, and 11 per cent. to roots. Fodder crops and roots each represented 7 per cent. of the arable crops. The number of horses is small. Dairy cattle represent about 28 per cent. of total cattle. About 95 per cent. of the "feeding cattle" are bought, mainly (65 per cent.) in the spring. Barren cows represent 23 per cent. of the feeding cattle, and bullocks (steers) 53 per cent. On the scale adopted—one bullock, one year, etc.—this comparatively rich pasture area carried on the average 0.56 unit, or a little more than half a bullock per acre; with 0.83 of a sheep unit in addition. Total of all stock in "sheep units" amounted to 418 per 100 acres, or about 0.6 of a "bullock unit" per acre. The total labour engaged, including actual work of farmers and their families, represented 1.37 "man equivalents" per 100 acres. The value of "equipment" was naturally small, being on the average only £1 4s. per acre. Average rental value was about £1 16s. per acre, but only about 55 per cent. of land was rented, while 45 per cent. was owned by occupiers. Financial accounts were obtained from farms covering 11,400 acres. Over the whole group receipts amounted to about £16 3s. 7d., and expenditure to £15 8s. 5d., leaving a "margin" of

15s. 2d. per acre. Expenditure on cattle represented 65 per cent. of the total, and receipts by sale of cattle to 80 per cent. of the total receipts. The full tables should be consulted. Gross sales " per man equivalent " amounted to £432. The charts illustrating supplies and prices of stock in markets are useful.

A very useful piece of work on a much neglected subject. The grazier's business was suffering under depression at the time of the survey, and in the period for which accounts were obtained, and has continued to suffer. But this is an old form of the agricultural industry which has previously met various vicissitudes and it will probably succeed in adapting itself to modern conditions. A.W.A.

INSURANCE.

Agricultural and Live Stock Insurance.

Arthur Jones, *Scottish Journal of Agriculture*, Vol. XI, Nos. 2, 3, and 4 (and reprinted).

These articles provide a useful preliminary survey of a much neglected subject. The special insurance business of farming has not received from the majority of insurance offices the attention that it deserves. When the farmer wants to insure his crops against hail or his live-stock against the risk of mortality the present system does not easily lend itself to meet requirements. The growth of the N.F.U. Mutual Insurance Society is noted. There has been a great growth of farmers' mutual insurance in the United States (and some in Canada), and there are also State Hail Insurance facilities. In Continental Europe much more attention has been paid to agricultural insurances than in this country. In France there were some 16,000 mutual societies, and over 600 received State subsidies (1924). In England and Wales the existence of some butchers' or auction mart insurance schemes is noted, and some experiences are given. Some recent experience of cottagers' and smallholders' mutual insurance of cows and pigs is analysed. An effort was made to measure the risk of mortality amongst farm livestock, and some Welsh farmers co-operated. Average rates of mortality for 1925 and 1926 respectively were:—*all* cattle, 2.15 and 1.98; *all* horses, 2.6 and 2.57; breeding ewes, 4.72 and 3.82; breeding sows, 4.73 and 3.32 per 100. The full tables should be consulted: both these tables and the analysis of causes of death amongst horses will be of interest to farmers. A.W.A.

MARKETING AND CO-OPERATION.

Agricultural Co-operation in North Wales: A Study in Experience, pp. 82.

J. Morgan Jones and R. Harding Wynne, Agricultural Economics Department, University College, Aberystwyth, 1928.

The authors of this very interesting and instructive bulletin deserve the highest praise for their searching analysis of the agricultural co-operative movement in North Wales since its official inception in 1904. In the past the tendency with regard to agricultural co-operation has been either to criticise or commend, with very little reference to the economics of the movement. We have in this study not only the usual statistical history of the movement but also a sound analysis of the various factors which determine the success or failure of any business venture. After a brief introduction indicating the growth of agricultural co-operation in North Wales from 1904 to 1925 the authors treat of the general position in 1926. This chapter is followed by a description of a number of societies created for various objects during the period under review. In view of the strides made in wool marketing in certain areas of England it would be worth while for the Welsh farmers to consider some scheme of disposing wool other than those existing to-day. The account of the Caernarvon Wool Society given in this study should be of value if a wool marketing scheme was considered. Chapter III is devoted to the Anglesey Egg Collecting Depot and the Tables included in this chapter on " margin of income ", " handling costs ", and so on should prove very helpful to those who propose setting up Egg Stations under the National Egg Marketing Scheme. Chapter IV is noteworthy for its excellent analysis of the co-operative cheese factories which on a small scale had a mushroom-like growth for three years after the war. Before any more of these factories are set up, a careful study of this chapter should be made by all North Wales farmers.

Organisation is the great need of the farming community to-day. If " Co-operation " is to fill that need, more " Studies in Experience " are needed throughout the country. A.J.

Agricultural Products; Co-operative Marketing of.

M. Murphy, Cork University Press, 1928. 140 pp.

This analytical study, dealing mainly with large scale co-operation in North America was made as the result of the writer's visit to that country. The outlook is constructively critical throughout and Mr. Murphy succeeds in giving an unbiased judgment of the situation. The first section of the book discusses the general problem of marketing from a co-operative standpoint. Then follows a description of the organisation and functions of large scale co-operatives in Canada and U.S.A., and in one chapter the difference between the " centralised " and " federated " types is analysed. On the whole the writer thinks that as a business organisation, the " central ", in its ability to control a large proportion of the product and thereby introduce grading and the pool principle, is more efficient than the " federated " type. In Section III are examined the essential features of successful organisation—such as the provision of essential services, adherence to the commodity principle, good management and the intelligent support of members. Further chapters are devoted to the means of securing such results in practice. The concluding chapter summarises the economic possibilities and limitations of collective marketing, and ends up with the view that the final results are determined by the educational level of the rural population. J.M.J.

Butcher's Shop; The. A Study of a Country Butcher's Business. pp. 32.

J. B. Short, Agricultural Economics Research Institute, Oxford. 1928.

This study " is an attempt to portray some aspects, financial and general, of a business which is often the subject of comment based on the flimsiest of data, if on any at all ".

The picture presented is not applicable to any butcher's shop, but represents one instance of a particular butcher's business on a basis of recorded facts for one year. There is no intention on the part of the writer that the facts emerging from this study should be applied to any other instance. The information relating to the financial aspects is certainly only applicable to the case under review, but the diagrams of beef, mutton, and pork carcases, with relative weights and values of the various cuts, and offal weights and values shown, are capable of fairly general application by the discriminating reader.

The writer deals with the method of purchasing and the type of stock purchased. Weekly requirements and transit from market. Preparations for, and methods of slaughter. The cutting of the carcases, and the weights of the various cuts of beef, mutton, and pork, and the analysis of expenses and returns per carcase and per week are treated. The weights and values of offals in the case of different animals are given. There is also an interesting analysis of the meat requirements of different classes of customers, with a discussion of seasonal fluctuations in demand, and of customers' credit.

The study provides valuable information on a subject of which little is known, and emphasises the need for further investigations of a similar nature under the widely varying conditions of different localities and markets. T.L.

Co-operative Associations (Fluid Milk); Membership Relations of.

J. W. Jones, *U.S.D.A. Circular*, No. 41, 1928.

In the development of successful co-operative marketing associations the problems arising from the relationship which exists between the members and the " management " are amongst the most difficult to solve. Policies may be adopted with a view to what is apparently expedient for purposes of membership morale but at variance with better business methods and with economic organisation essential to permanent solution of the marketing problem. This is a report of an investigation of the relations between " management " and members, and the information is given largely in statistical tables. To the question, " what did you expect the organisation to accomplish ?" 53 per cent. replies were " better prices " and 24 per cent. " better marketing conditions "; 792 members out of 911 were satisfied with the officers of the associations; but only 547 out of 774 believed that the associations were efficiently managed. Some 57 per cent. of members had no criticisms of the organisations. Only about 28 per cent. of members had attended annual or district meetings of the associations. Amongst non-members of associations nearly half were of opinion that they had benefitted by the activities of the organisations, and more than half believed that the associations had raised the price of milk. More than two-thirds of the non-members said they would not like the associations discontinued.

These results of an American investigation have a strange similarity to general impressions formed about agricultural co-operatives in Wales.

A.W.A.

Developing New Industrial Markets for Farm Produce; The possibilities of.

Rudolph A. Clemen, *Circular* 330, University of Illinois. 1928.

A report of an address by the Assistant Director of Armour's Livestock Bureau, Chicago. Both industrial decentralisation and the chemical revolution may go far towards meeting the difficulties that vex the farmers. If certain researches of chemists, successful on a laboratory scale, can be made commercially practical in producing fructose (fruit sugar) from Jerusalem artichokes it may mean the end of the beet- and cane-sugar industries. Milk albumin, milk sugar, and casein are valuable, and there is a market for them, but manufacture is small, while scientific knowledge has not been fully applied in commercial practice. New factories are being built every year to utilise straw in paper and cardboard manufacture. From corn-cobs " furfural " (an aldehyde) is being made. Furfural-resins are developing. Building and insulating boards are being made from different fibres. Other instances of use of farm waste or by-products are given. The problem of economic assembly of waste products is important; but " from the point of view of individual business the manufacture of by-products has turned waste into a source of revenue ". An optimistic but stimulating discussion. A.W.A.

Farmers' Co-operative Business Organisations in New York.

J. F. Booth, *Bulletin* 461, pp. 124. Cornell University, March, 1928.

Following upon detailed description of the many forms of co-operative enterprise in New York State, this bulletin proceeds to examine the business make-up of various types of societies. The analysis of business statistics elucidates the relative advantages of the stock and non-stock forms of organisation. It is concluded that the " capital-stock " method should be adopted by concerns requiring much fixed capital, whereas collective bargaining societies can proceed efficiently with a revolving fund, provided the period of maturity is not too short. Further aspects of success and failure are treated in the latter part of the report, and attention is drawn to the necessity of good management and careful accounting. It is the author's view that the majority of co-operatives succeed because they offer a genuine service and have therefore won for themselves an important position in the field of agricultural business.

J.M.J.

Grain in Western Canada; Co-operative Marketing of.

J. F. Booth, *U.S.D.A. Technical Bulletin*, No. 63, Jan., 1928. pp. 115.

Grain Growers' Co-operation in Western Canada.

H. S. Patton, *Harvard Economic Studies*, 32, 1928. pp. 460.

The Wheat Pools Movement is handled on similar lines by both these writers, except that Professor Patton enlarges on the results, limitations, and future outlook of the movement. Early attempts at producers' control are described, together with the experience of government control of wheat marketing. The pool system was adopted both because farmers were satisfied with the operations of the Wheat Board of the war period and because they realised the weakness of their local co-operative elevators in competition with line companies. Economic necessity, resulting from de-control in 1923, together with the expansion of production, gave birth to regional pools, the groundwork for which had been prepared by previous experience in co-operation. Since 1924 there has been much change in the policy of the pools, especially in the regard to the acquisition of country and terminal elevators. By the introduction of contracts, direct selling and the pooling of supplies and receipts, the co-operation of grain growers has revolutionised the marketing of wheat in Canada. While recognising the general success of the movement, Professor Patton insists that an international price *controlling* pool is an impossibility. In Mr. Booth's opinion the experience of the past four years has amply demonstrated to the Canadian farmer the supreme benefits of large scale co-operation. Both writers emphasise the educative and moral aspects of successful organisation. J.M.J.

International Wheat Pool Conferences; Proceedings of.

(*a*) 1926, St. Paul, Minn.; (*b*) 1927, Kansas City, Miss., U.S.A.; (*c*) 1928, Regina, Sask., Canada.

The student of large scale co-operation will find in these reports a wealth of information on the organisation, problems and policies of wheat pools all over the world. Pool organisation on a large scale in surplus producing areas all over the world logically resulted in the institution of an International Conference, since the fact of different areas producing for a world market led to their having common interests and problems. The magnitude of their operations has brought about the bogey of a world wheat trust and delegates seek to prove that strengthening the producers' position is not inconsistent with the real interests of the consumer. Following from this the later conferences have discussed the general question of improving relations between producers and consumers, besides emphasising the pools' activities in improving the quality of cereals. Success in the past is largely attributed to the supply contract and the real service which the pools have rendered their members, together with the support given them by governments and business institutions. In the 1928 Conference special attention was devoted to considering the means whereby the adherence of members can be strengthened through sound education in co-operative aims and practices. In this connection the importance of bringing the farm womenfolk into the organisation was emphasised. The 1928 Conference was characterised by another feature: it was a general "pool" conference in which co-operatives handling products other than wheat on the pool principle were represented. It is evident from these reports that the wheat producers of the world have gone a long way in the direction of controlling their business destinies. J.M.J.

Live Stock and Meat; Better Marketing of.

Report from the Standing Committee, Council of Agriculture for England. Printed in *Journal of the Ministry of Agriculture*, December, 1928, and reprinted.

For the purposes of considering possible improvements in the systems of marketing farm produce the Council of Agriculture for Wales has been represented on the Standing Committee mentioned above. A series of short practical reports have been under consideration and some have been issued. The above Report was adopted by the Council of Agriculture for Wales, meeting in January, 1929.

Inter alia the Report states: A system of grading fat cattle on presentation at the live stock markets is desirable. A better plan than grading of live stock would be co-operative slaughter and grading by quality of actual meat. The direct selling of meat by or on behalf of the farmer would have a very beneficial effect on the quality of meat produced. As no general movement towards this end can be anticipated, it is necessary to secure a better organisation of markets for grading, and for the provision of market intelligence on supplies and prices. Store cattle might also be graded for sale. Problems of buying store and selling fat sheep are often peculiar to the several districts, but farmers would benefit by a system of grading meat.

The Report draws attention to the increase in the autumn supplies of beef and the decline of prices at that time. Also, to the unsatisfactory position of home-grown meat on wholesale markets, which is " either the result of error on the part of meat buyers " or that " of persistent production of many inferior cattle by (British) farmers ", or is a result of both factors working together. Steps must be taken to increase the reputation of British beef, and this can best be done by efficient grading and marking. It suggests the consideration of grading of meat itself, and points out that marking of British meat grades would distinguish this from imported meat. Cattle killed at the point of production yield better meat than is obtained from cattle transported long distances.

A section on *Pigs and Pig Products* suggests that conditions of assembling and marketing fresh pork could be much improved. There is no doubt that pork and pork products might properly occupy a more important place in the dietary of the nation. Few bacon factories are running at full capacity, and many do not reach more than half-capacity, because of lack of sufficient suitable pigs. Impediments to full production should be speedily discovered and set aside. A.W.A.

Marketing Country Creamery Butter by a Co-operative Sales Agency. H. BRUCE PRICE. pp. 45. *University of Minnesota Bulletin*, 244, March, 1928.

In its opening sections this bulletin discusses the need of a central marketing agency for a large number of co-operative creameries which manufacture two-thirds of the butter output of Minnesota. Co-ordination was partly dictated by the difficulty of maintaining supplies which were uniform in quality and this problem has largely been solved by the field and inspection service of the Land O'Lakes Creameries. Since 1924 this organisation has developed a central sales agency, which is responsible for expanding the markets for the " 93 score " butter manufactured by member creameries. By maintaining a high standard of quality, the Association is able to advertise and cater for the various needs of customers in different States. The pool principle is proving advantageous to members, and they secure additional benefits from the requisites trade of the agency. The analysis of capitalisation indicates the efficiency of the revolving fund system whereby a business can readily secure for itself a fund of working capital commensurate with its trading needs. J.M.J.

Markets and Fairs in England and Wales. Part III.—Northern Markets. No. 19. Economic Series, Ministry of Agriculture and Fisheries. 1928.

This report is complementary to Nos. 13 and 14 of this series and deals with 496 markets and auction marts in the northern counties from Lancashire and Yorkshire to the Scottish border. The general view in the first section deals with the main characteristics of organisation and charges, and shows clearly that, as elsewhere, the fairs are declining in importance. In the other two sections descriptions of county, local and individual conditions are given. It can be said that surveys of this character have two main purposes: to provide detailed information for all concerned with the marketing of farm products in the various areas, and to offer a basis for judging the adequacy and efficiency of the markets in relation to their economic environment. J.M.J.

Milk and Cream in New England; Some Economic Aspects of the Marketing of.

W. A. SCHOENFELD. Circular No. 16, Bureau of Agricultural Economics, U.S.D.A. October, 1927. pp. 73.

The object of this study is to determine the economic background of the re-organisation of liquid milk marketing in the New England States. The preliminary survey of supply and demand shows how the reduction of freight rates has enlarged the liquid milk producing areas of these States, and how the resulting deficit in fresh cream supplies has been met by shipments from the Middle West. A review of country collecting points shows the necessity for a rational grouping plan so that uneconomic plants may be reduced in number and that more depots can avail themselves of the favourable rates for Car load and Tank-car lots. A discussion of fluctuations in supply shows the paramount importance of feed costs in controlling production, while studies of demand show the inelasticity of the demand for fluid milk. Knowledge of supply, demand, and costs offers a basis for the forecasting of supplies and prices, and must be considered in price negotiations. After reviewing the merits and problems of the various methods of making price agreements, the author concludes that the urgent needs of the milk industry in the area is " co-ordination in production, assembling, converting, shipping, and city distribution ". J.M.J.

Milk Marketing based on conditions in Wiltshire, Somerset, and Bristol; A Survey of.

F. J. PREWETT, Agricultural Economics Research Institute. Oxford Press, June, 1927. pp. 74.

This very detailed study of milk marketing shows the wide differences in the organisation of production and sale in Wiltshire and Somerset. Typical parishes in the area are taken and the destination of each producer's supplies are shown. Another section gives a detailed account of urban distribution and the maps show the enormous wastage which arises from the lack of directed movements of supplies. Another section deals with the distribution of assembly depots and factories, and demonstrates the hold of large scale private organisations in the liquid and manufacturing trades. The importance of manufacturing can be appreciated when it is realised that only 40 per cent. of the June supplies of the area are sold as liquid milk. As the result of his careful survey, Mr. Prewett is able to assess the degree in which producers' control in the area is effective. While a number of co-operative factories serve as a price insurance, the majority of farmers put their trust in collective bargaining. The essential weakness of collective bargaining in milk is that the highly perishable nature of the commodity restricts the control which can be exercised by the producer. Collective bargaining can only become effective when producers own and control an organisation which can keep surplus milk from entering the liquid market. The appendix gives the essential features of such forms of control as worked out by the South Wilts Milk Society and the Scottish Milk Agency. This type of marketing research is of great practical value to those interested in the organisation of marketing in any area. J.M.J.

New York Milk Market; The Demand Side of the.
H. A. Ross. pp. 86. *Cornell Bulletin*, No. 459. July, 1927.

This detailed survey deals first with differences in the grades of milk demanded in various sections of New York City. It then proceeds to examine the influences creating fluctuations in demand and these are illustrated from records of wholesalers' and retailers' sales of the various grades of milk. Long-term demand changes are controlled as regards total demand by the population and as regards per capita demand by such factors as industrial prosperity and the competition of substitutes for milk. The examination of the regular seasonal changes show clearly the influence of vacation periods on sales, since there are times of general exodus of people from the city, though this applies unevenly to the different districts. Temperature changes are responsible for regular seasonal variations, particularly so in the sales of butter milk. Day to day variations are also examined, and it is shown that on the whole small consumers vary their consumption more than the larger buyers. Irregular changes are caused by abnormal differences of temperature and individual holidays upset average conditions. It is concluded that the demand for milk is fairly inelastic; that a 10 per cent. change in price causes a 2 per cent. change in demand. It follows that perfect adjustment must be aimed from the side of supply. J.M.J.

Pork and Bacon Trades in England and Wales.
No. 17. Economic Series, Ministry of Agriculture and Fisheries. pp. 202. 1928.

By the issue of this report, the survey of the home pig industry, begun in the *Report on Pig Marketing*, has been completed. This report is a detailed survey of the processes and problems involved in the preparation of pig products for consumption, together with a review of the position as regards imports of such products. In the review of the pork trade since the imposition of the embargo on Dutch imports it is pointed out that the home producer has not met the deficit in point of quality, and the necessity for some system of carcase grading is emphasised. The raw material problem, both in the matter of quality and regularity of supplies, is very acute in the home bacon industry. The responsibility for this must be shared by producers who alternate production between pork and bacon; by the curers in that market requirements are not made articulate; and by a marketing system which neither pays a premium on quality nor secures the most suitable allocation of supplies. The present unsatisfactory position calls for urgent reform in two directions. Curers must decide what their requirements are, and consider the setting up of standardised grades to which offers of prices will conform. Furthermore, farmers should organise co-operative live-pig marketing associations to facilitate the movement of graded supplies to the curers. In the remaining sections, the report deals with the marketing of pig products other than pork and bacon, considerable attention being given to the question of eliminating waste. J.M.J.

Producers and Consumers: A Study in Co-operative Relations.
MARGARET DIGBY. pp. 195. Horace Plunkett Foundation, 1928.

The writer of this book is to be complimented on the apt way in which a knowledge of the theory, practice, and business problems of co-operation has been brought to bear on the questions of the organisation of producers and consumers. The historical section, together with data of an international, imperial, national, and local character defines the nature of the problem and shows to what extent some fundamental difficulties are being overcome. A clear distinction is naturally made between the relation of the industrial movement to the farmers' organisation in its dual capacity as a buyer of requisites and a seller of foods. Inter-trading in the matter of farm requisites should, in Miss Digby's opinion, be developed even to the extent that the C.W.S. should undertake the direct manufacture for sale of the farm requisites which are not mere by-products of its activities in catering for the town population. It is intimated that the real obstacle in the matter of joint trading in farm produce is the unequal bargaining power of producers and consumers as at present organised in this country. Some colonial instances are cited wherein the strength of the growers' organisation places the industrial movement in a subservient position. The theoretical advantages of "organised producers selling to organised consumers" will be secured by the development of marketing societies on the part of producers. This study is a valuable contribution to our knowledge and ideas on an extremely important and practical problem. J.M.J.

Supply and Price; Inter-relations of.

G. F. WARREN and F. A. PEARSON. *Cornell Bulletin*, 466. March, 1928. pp. 144.

The writing of this pamphlet was promoted by the authors' dissatisfaction with the rather slip-shod way in which the factors which control prices are commonly treated. With the aid of a mass of well-digested statistics they approach the problem afresh from a commodity standpoint. The result of this method goes to show the relative importance of changes in supply, prices, total value, total production, deflation, and the prices at various points between producer and consumer in each case. The evidence justifies the writers' contention that consumption is determined by retail prices and production by farm prices, and not by wholesale prices. The supreme importance to an agriculturist of a study which leads to the conclusion that "if farmers received their pre-war share of retail prices there would now be no agricultural depression" cannot be over-emphasised. J.M.J.

RURAL SOCIOLOGY.

Standards of Living in Agricultural Communities.

The Farmer's Standard of Living. *U.S.D.A. Bull.*, No. 1466, 1926.

Relation between Ability to Pay and Standard of Living amongst Farmers. *U.S.D.A. Bull., No.* 1382, 1926.

How Minnesota Farm Incomes are Spent. *University of Minnesota Bull.*, 234, 1927.

Family Living on Successful Minnesota Farms. *University of Minnesota Bull.*, 240, 1927.

The Standard of Life in a Typical Section of Diversified Farming. *Cornell University Bull.*, 423, 1923.

Making a Budget. *Cornell Reading Course*, No. 124.

It is interesting to speculate to what extent the present depression in British farming is the result of failure to realise expectations stimulated in war years, and to what extent the results of the depression have reduced standards of living, say, below the level enjoyed in the years 1910-14. It may also be a very practical subject to consider. But in Great Britain there is no general information on such important matters. The above selection has been chosen to illustrate the interest in and the importance attached to standards of living by the Federal Department of Agriculture and some agricultural colleges in the United States. The list is by no means complete and could be very much extended. If the final objective of all study of agriculture is the improvement of rural living, the subjects of standards of living, methods of improvement, restrictions on changes, relations between standards and existing incomes, the relations between incomes and desires for living conditions are all-important. There can be no doubt that from a general social point of view improvement of rural living is one of the most important objectives of agricultural education and research. In Wales there is no doubt that in some districts improvements in farming practices and business methods are retarded by lack of incentive to reach higher standards of living—especially for the whole group. There are people in rural communities who believe that part of the advantage of being better-off or better provided for are lost if all or a majority of families improve together. They desire incomes or accumulated wealth as a means of commanding social esteem or of securing social distinction. " Money " is the desideratum, while standards of living are largely determined by habits and traditions. This position is being changed in some respects, notably by the motor car and by the extension of the secondary school system.

But here are studies dealing with expenditure of farm families on foodstuffs, clothing, furniture and furnishings, maintenance of health, insurance, personal goods, advancement goods (education, etc.), in relation to economic status (ownership or tenancy), incomes, education of parents and other factors in earning power, desire to live well, and ability to spend intelligently. The work does not end with mere study, for it leads to education and advisory work on budgetting and spending : it may also have considerable influence on the direction and intensification of agricultural education. A.W.A.

The Representation and Organisation of Agricultural Workers.

Studies and Reports: Series K (Agriculture), No. 8. International Labour Office, Geneva, 1928.

A study of the representation of agricultural workers in the International Labour Office, League of Nations; and a further study of the industrial organisation of farm workers in a number of countries. The study necessarily includes the smallholder or the " peasant " farmer, together with the *métayer*, or share tenant. For instance, in Denmark there is a Union of Danish Landworkers; and the Danish smallholders are organised in about 1,100 local organisations with 82,000 members, which are again united in six provincial associations. In France there have been several organisations of agricultural and horticultural workers. Some of these have enrolled smallholders, small tenants, share-tenants who work independently or with members of their family. But details are given for twenty-eight countries. The very difficult problem of protecting the interests of tenants is touched upon, and the possibly still more difficult problem of protecting share-workers is dealt with more fully. Queensland (Australia) treats the share-tenant as a worker in respect of employer's liability in industrial accident. These problems do not exist in Great Britain--the first because of the Agricultural Holdings Act—but they do in the British Empire. This is a valuable contribution to a very complicated but important subject. It deserves study by all those who are interested in the economic organisation of agriculture outside the British Isles. A.W.A.

ANIMAL NUTRITION.

Abstractor:

R. O. DAVIES, M.Sc., University College, Aberystwyth.

Calf Meal Studies: I, Laboratory Experiments in Improving the Physical Condition; II, Feeding Experiments with Cooked and Uncooked Meal.

J. G. ARCHIBALD, *J. Dairy Sci.*, 1928, XI., 2, 119-135.

Gelatin, taken as a type of protective colloid, was found to be without effect on calf meal gruels as ordinarily prepared. Moderate heating seemed to be the most efficacious way of improving the physical condition of the gruels. It accomplishes the same end as does fine grinding or adding gelatin, and is much more practicable. Practical feeding experiments showed that the cooking of reasonably fine calf meal does not appear to exert any favourable effect on growth, the calves receiving the raw meal putting on 1.05 lbs. per day as compared with 0.95 lb. per day for the calves receiving cooked meal. The digestibility of a calf meal is not significantly affected by cooking. R.O.D.

Calves; The Effect of High and Low Protein Rations on the Food Value of Milk for.

C. C. HAYDEN and W. E. KRAUSS, *Oh. Agr. Expt. Sta. Bimon. Bul.*, 13, No. 2, 55-58 (1928).

One group of cows was fed a ration with a nutritive ratio of 1 : 2, while the nutritive ratio in the ration of another group was 1 : 13. The milk from these groups was fed to calves which had sucked their dams for three days after birth. At three to four weeks of age lucerne hay and a grain mixture was introduced into the rations of the calves.

The growth of the calves on the milk of the cows fed the low protein ration tended to lag somewhat until hay and grain were fed, but after that there was no difference of note. R.O.D.

Cellulose Digestion; The Mechanism of—in the Ruminant Organism.

II, The Transformation of Cellulose into Glucose by the agency of Cellulose-Splitting Bacteria.

H. E. WOODMAN and J. STEWART, *J. Agri. Sci.*, 1928, 18, 713-723.

These experiments confirm the results of previous German investigations which showed that glucose can be produced by the controlled action of cellulose-splitting micro-organisms on filter paper.

It is further shown that glucose can be produced from the crude fibre of oat and tare silage by a similar action. The formation of glucose is considered as taking place in two stages, the second stage of the fermentation being the result of the activity of emzymes. R.O.D.

Cod Liver Meals; Antirachitic Properties of.

R. Bethke, G. Zinzalian, D. C. Kennard, and H. L. Sassaman. *J. Agric. Res.*, 1928, 36, 747-753.

The antirachitic value of cod-liver meals (which consist of the dried residues after extraction of the oil) is below that of the fresh oil. Experiments with rats and chickens show that the residual antirachitic properties vary considerably, but are not proportional to the oil remaining. The authors conclude, therefore, that it would be unwise to use cod liver meal as an antirachitic substitute for a good grade of cod liver oil in either poultry or live stock production. R.O.D.

Cod Liver Oil; The Chemical Composition of the Milk of Cows receiving.

(Preliminary paper). E. C. V. Mattick, *Biochem. J.*, 1928, XXII, 1, 144-149.

The results of these experiments indicate that the addition of cod liver oil results in changes in the chemical composition of the milk, particularly an increase in the percentage of total calcium. Further work is in progress. R.O.D.

Cooking; Effect of—on Nutritive Value of Foodstuffs.

E. Friedberger, *Die Volksernährung*, Berlin, 1927, Jahrg 2, Heft 15.

These experiments with rats show that a good foodstuff if cooked too long deteriorates. Trials with raw foodstuffs gave the most favourable results as regards increase in weight. R.O.D.

Cottonseed Meal as a Feed for Dairy Calves.

O. E. Reed, C. F. Huffman, and L. H. Addington. *J. Dairy Sci.*, XI, 1928, 6, 488-507.

Cottonseed meal injury in cattle is similar, if not identical, to the injury produced when too much concentrates in proportion to roughage is fed. The results of this experiment indicate that at least two pounds of cottonseed meal per day can be fed without injury to calves which have reached five months of age, provided they receive all the silage and hay of good quality they will eat.

The results of this investigation are not in harmony with the generally accepted idea that the feeding of linseed oil meal makes a sleeker coat and a more pliable hide than when cottonseed is fed. There was very little difference between the lots of animals in this respect.

The results also failed to demonstrate the idea that linseed oil meal has a more laxative effect than cottonseed meal. There was no appreciable difference between the two groups of heifers in the rate of food passage, and there was no measurable difference in the consistency of feces excreted by the two groups. R.O.D.

Ewes and Lambs; Maintenance and Production Requirements of.

T. B. Wood and W. S. Mansfield. *J. Min. Agri.*, 1928, 35, 211-219.

The investigation shows that the maintenance requirement of sheep can be found by inspection of a curve which gives maintenance requirement in relation to live weight. The production requirement of lambs can be found by inspection of a curve which gives production requirement in relation to age. The production requirement of suckling ewes is about 3 lb. of starch equivalent per gallon of milk. An average ewe yields from 2¼ to 3¼ gallons of milk per week, and the milk contains 2.67 starch equivalent per gallon. R.O.D.

Fish Meal in the Rations of Fattening Pigs; Substitutes for.

T. B. Wood, J. B. Orr, C. Crowther, H. R. Davidson. *J. Min. Agri.*, 1928, 35, 409-422.

The value of fish meal for feeding to pigs, as a supplement to a basal ration of cereals, has been investigated and found to be associated with the protein, and particularly with the amount and proportions of the mineral ingredients. The oil in fish meal not only appears to be of no special value for growth, but to have a slight depressing effect on live weight increase. Vegetable proteins, when used in the proper proportions, and when carefully supplemented by mineral mixtures give as good results as the animal protein in fish meal. In neither case, however, was a carcase of first class quality obtained. The quality of the fat and the conformation of the carcase are not always the best in the case of pigs with the greatest live weight increase. R.O.D.

Mineral Metabolism; Studies in.

III, Breeding of Cattle on Phosphorus Deficient Pasture. A. Theiler, H. H. Green, and P. J. Du Toit. *J. Agri. Sci.*, 1928, 18, 369-383.

On the arid, sparse, phosphorus deficient pasture of the Vryburg district of the Cape Province, grading up of scrub cattle, by combining the introduction of pure bred bulls with the feeding of bone meal to the cows, is attended with great success so far as shown by the first crossing. Remarkable differences in favour of the mineral supplement are shown, in respect to reduced mortality incidence, increased fertility of cows, and superior development of calves.

V, Composition of Bovine Blood on Phosphorus Deficient Pasture. A. I. Malan, H. H. Green, and P. J. Du Toit *Ibid.*, pp. 376-383.

Data are recorded concerning the blood of cattle grazing over phosphorus deficient pasture of the Union of South Africa. The outstanding characteristic is low inorganic phosphorus, with a correlated reduction in total phosphorus. When a small ration of bone meal is given to the cattle, comparatively normal figures are shown. R.O.D.

Pasture; Nutritive Value of.

III, The influence of the intensity of grazing on the composition and nutritive value of pasture herbage (Part I). H. E. Woodman, D. B. Norman, and J. W. Bee. *J. Agri. Sci.*, 1928, 18, 266-296.

The difference in chemical composition between pasture grass cut at weekly and fortnightly intervals are inconsiderable. The results of digestion trials indicate that the dry matter of pasture herbage grown under a system of fortnightly cutting is a protein concentrate equal in digestibility and nutritive value to that obtained by weekly cutting. The conclusions arrived at under the system of weekly cuts respecting the desirability of employing carbohydrate instead of protein concentrates for the purpose of supplementary feeding on closely grazed pasture still hold good for pastures under a somewhat more lenient system of grazing.

Although intensification of the system of cutting tends to depress productivity, the difference between weekly and fortnightly systems is not sufficient to bring out this effect very prominently. When meteorological conditions lead to a slowing up in the rate of growth (as during a spell of droughty weather), productivity under a system of cutting at fortnightly intervals becomes markedly higher than under a system of weekly cutting.

The speedy stimulation of growth of wild white clover, which becomes possible by the adoption of a system of close grazing, is again strikingly illustrated on a heavy land pasture plot. R.O.D.

Pigs; Some Preliminary Experiments on the Value of Small Quantities of Whole Cows' Milk when fed to.

A. H. Blissett and J. Goulding. *J. Agri. Sci.*, 1928, 18, 642-648.

Preliminary experiments are reported, in all of which marked differences were observed when half a pint of milk was fed in addition to well-balanced rations. The milk appeared to supply some extra factor or factors.

The total dry matter consumed per lb. increase in live weight was diminished by the milk feeding. This supports the contention that milk may have a specific action in increasing the extent to which a given food stuff is digested. Half a pint of milk per pig per day seems to be a suitable minimum quantity to give daily to porkers. R.O.D.

Poultry; Digestibility Trials with.

E. T. Halnan. *J. Agri. Sci.*, 1928, 18, 421-431, 634-641.

II, Digestibility trials with wheat carried out with White Leghorn cockerels indicate that " weak " and " strong " wheats are equally suitable as sources of supply of food nutrients for poultry. In the production of wheat for poultry feeding, yield rather than strength should, therefore, be the primary aim of the grower.

III, Digestibility trials with " whole " maize and " flaked " maize indicate that steam cooking by commercial processes considerably increases the digestibility of the food nutrients in maize. The view held that the fowl is akin to the pig so far as its powers of digestibility of low fibre foods are concerned is substantiated.

IV, Digestibility trials with oats indicate that certain varieties of oats are more suitable as sources of food nutrients for poultry than others. In the trials carried out Grey Winter oats proved more suitable than Black Bountiful or Scotch Potato oats for poultry feeding. The suitability of varieties of oats for poultry feeding appears to be linked with the fibre content, and thin husked varieties appear to be most suitable for this purpose. Oats do not appear to be very palatable to poultry.

V, Palatability tests with bullrush millet indicated that this grain of Empire origin is in every way suitable as a food grain for poultry in all stages of growth. Digestibility trials have proved that this grain is readily digested by poultry. Bullrush millet, on a digestibility and composition basis, appears to approximate in feeding value to Little Joss wheat.

VI, Four White Leghorn cockerels were fed with widely varying quantities of a Sussex ground oats and milk mixture without material alteration in the coefficients of digestibility of the digestive nutrients. The amounts fed varied from a sub-maintenance ration of 50 gm. to a "limit of appetite" ration of 150 gm. It is concluded that, in feeding experiments with fowls, the coefficients of digestibility of the food nutrients are not materially affected by the variations in the amounts of food fed. R.O.D.

Protein and Lime in the Ration of Fattening Pigs.

T. J. SHAW. *J. Min. Agr.*, 1928, 35, 342-347.

The results of a series of trials carried out with pigs are given. It is concluded that a deficiency of lime such as is common to many farm rations has serious effects on the growth and health of the pig. The meat meal used throughout the trials was a special product, very short of mineral matter. This class of protein food as available on the market has for the most part sufficient mineral content to meet the needs of the fattening pig, but it is important in its purchase to pay some attention to its lime and phosphate content. R.O.D.

Protein; High and Low—Feeding Experiment. (Progress Report).

A. E. PERKINS, *Ohio Agri. Exp. Station*, Wooster, Ohio.

Previous work has shown reasonably satisfactory results with rations ranging from 1.4 to 1.11 in nutritive ratio.

The extremes of 1.2 and 1.18 which are now in use for experimental purposes are both failing to maintain the cows in proper condition and giving smaller production than intermediate rations. There are strong indications that breeding difficulties are developing. R.O.D.

Rations; The Food Value of Milk as affected by.

The effect of High and Low Protein. (Progress Report). W. E. KRAUSS, *Ohio Agri. Exp. Station*, Wooster, Ohio.

It was found at the Ohio Agricultural Experiment Station that when cows were fed with rations with nutritive ratios of 1.4 and 1.9 production was maintained and the chemical composition of the milk remained unchanged. In order to arrive at the limits of protein, having rations of wider diversity, nutritive ratios of 1.2 and 1.18 were fed to two groups of three cows each, and a study of the nutritive value and chemical composition of the milk produced on these rations was made.

A slightly greater amount of vitamin A, in keeping with the amount furnished in the feed, was found in the milk of the high protein cows. There was some indication that milk from cows fed a ration extremely low in protein is lower in nitrogenous constituents and ash, higher in lactose than that from cows fed a ration extremely high in protein.

R.O.D.

Salted Feeds; Influence of—on Milk Production.

E. MARRE. *Comptes rendus des Séances de l'Académie d' Agriculture de France*, Paris, 1927, V. XIII, No. 11.

Taking into account the decrease of daily yield inherent in the lactation, it is observed that in cows and ewes the decrease of the milk was considerably modified by the addition of salt to the ration.

As regards the influence of salt on the quality of the milk, the fear expressed in certain quarters that the increased yield in the ewes would be prejudicial to the richness of the milk does not appear to be justified. The addition of salt does not diminish the richness of the milk in solids and fat, and even slightly increased it in some cases. R.O.D.

Sugar Beet Pulp; The Composition and Nutritive Value of.

H. E. WOODMAN and W. E. CALTON. *J. Agri. Sci.*, 1928, 18, 544-568.

Data are given respecting (1) The composition and digestibility of wet sugar beet pulp; (2) The composition of dried sugar beet pulp and its digestibility when fed to ruminants (*a*) in the dry condition, and (*b*) after preliminary soaking in water; (3) The composition of molasses sugar beet pulp.

Sugar beet pulp is shown to be highly digestible in the ruminant organism. Drying does not depress digestibility, and the dried pulp can be regarded as a carbohydrate concentrate, 1 lb. of which is capable of replacing 0.8 lb. of maize or 0.9 lb. of barley in the productive part of the rations of ruminants. The digestion coefficients of the protein is relatively low, but that of the fibrous constituents and nitrogen free extractives is very high. Almost four-fifths of the total dry matter of the pulp is digested not by enzymic processes but by the agency of bacteria. R.O.D.

Sugar Beet Tops; The Nutritive and Manurial Values of.

H. E. WOODMAN and J. W. BEE. *J. Agri. Sci.*, 1927, 17, 477-488.

The results of investigations into the value of sugar beet tops both as a feeding stuff and a manure are included. From digestibility trials with sheep it is concluded that sugar beet tops form a feeding stuff of high digestibility, the carbohydrate being especially digestible. The high fibre digestion coefficient was also a noteworthy feature. The evidence obtained suggests that the lime in sugar beet tops may not be in a form available to the animal, possibly on account of the presence of oxalic acid in the leaves. R.O.D.

Winter Milk; The Influence of the Cow's diet on the Fat Soluble Vitamins of.

H. J. GOLDING and S. S. ZILVA. *Biochem. J.*, 1928, XXII, 1, 178-182.

A winter ration for cows, containing silage and hay, is described, which produced an antirachitic butter of moderate potency. The daily addition of 2 ozs. of cod liver oil to this ration did not significantly depress the percentage of milk fat, nor did it raise the vitamin D of the butter to any appreciable extent. Higher doses of cod liver oil depressed the percentage of milk fat and raised the antirachitic potency of the butter. R.O.D.

ENTOMOLOGY.

Abstractor:

J. R. W. JENKINS, M.Sc., University College, Aberystwyth.

Apple Sawfly (*Hoplocampa testudinea* Klug); How the Ribbon-like Scars on Apple are made by the.

PETHERBRIDGE. *J. of Pomology and Hort. Sci.*, VII, Nos. 1-2, July, 1928.

The author gives a detailed account of the way in which the ribbon-like scars are caused, and points out that they should not be confused with the much more irregular scars caused by *Plesiocoris rugicollis* Fall, the green apple capsid bug. Sawfly scars usually start near the calyx where the eggs were laid. J.R.W.J.

Black Currant Gall Mite, *Eriophyes ribis* (Westw.), Nal.; The Life History of the.

MASSEE. *Bull. of Entomological Research*, XVIII, Pt. 3, February, 1928.

Following an extensive summary of the observations of previous workers on the bionomics of this pest, the author gives the results of his own observations over a period of several years at East Malling. J.R.W.J.

Cabbage White Butterfly; The Large (*Pontia brassicae*)—and a simple Method of Control.

THEOBALD. *J. of the South Eastern Agricultural College, Wye*, No. 25, 1928.

An account is given of the bionomics of *Pontia brassicae* and of tests of many recipes for its control. The most successful treatment consisted of spraying with 2 ozs. of common salt in a gallon of water. This, however, scorches nasturtiums. J.R.W.J.

Capsid Bug found on Species of *Ribes*; Notes on the.

PETHERBRIDGE AND THORPE. *Entomologists Monthly Magazine*, LXIV, May, 1928.

Of the fifteen species recorded during a survey of the damage caused to currants and gooseberries in Eastern England, *Lygus pabulinus* L. appears to cause most damage, with *Plesiocoris rugicollis* Fall. the chief pest in some plantations. Notes are given on the food plants of the other species, which although taken on currants and gooseberries, caused no appreciable damage. J.R.W.J.

Chrysanthemum Midge; The.*

SPEYER. *Gardeners' Chronicle*, LXXXII, No. 2133, November, 1927.

An account is given of an attack in England on cultivated chrysanthemums, of the chrysanthemum midge *Diarthronomyia hypogaea* Lw. The midge has been known for some years to attack the wild ox-eye daisy in England, and in 1915, probably after exportation from Europe, became a pest of cultivated chrysanthemums in America, and has continued to be a serious pest there. It was first recorded on cultivated chrysanthemums in England in April, 1927. Although a variety of chrysanthemum imported about 1924 from the United States is susceptible to attack, and although with one exception the midge was found in all nurseries examined where this variety was grown, there is no definite proof that the outbreak was due to the importation of infested cuttings from America. Since the fly cannot travel long distances its spread may be prevented by limiting movement of infested plants and of plants which have been exposed to infection. J.R.W.J.

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* *Note.* In accordance with the Amendment Order of 1927 to the Destructive Insects and Pests Order of 1922, the importation of all unrooted cuttings and rooted plants of chrysanthemums into England and Wales is restricted, and the chrysanthemum midge is included in the list of pests the compulsory control of which may be required.

Entomology.†

MASSEE. *Annual Report East Malling Research Station*, 1927-28.

Continued trials of tar distillate washes showed the optimum strength to be 7½–10 per cent. Negative results were obtained when colloidal sulphur or naphthalene was included in an attempt to make the washes effective against red spider eggs. Further studies of the relative resistance of apple stocks to *Aphis pomi* De G. and mazzard cherry stocks (*Prunus avium*) to *Myzus cerasi* F, confirmed that even high degrees of resistance may break down at least temporarily. Apple seedlings produced by a cross between Northern Spy and Doucin II proved immune to woolly aphis (*Eriosoma lanigerum* Hausm.), even after severe tests. Several other crosses showed a high degree of resistance, while some were very susceptible. J.R.W.J.

Glasshouse Sanitation.

PARKER. *Fertiliser, Feedingstuffs and Farm Supplies J.*, *XIII*, No. 5, 1928.

The conditions governing the successful use of various methods of spraying, fumigation, and other cleansing methods are described and discussed. J.R.W.J.

Nicotine as an Insecticide.

WILSON. *Chemist and Druggist*, 1928.

A general account is given of the value of nicotine as an insecticide, and its application as a contact wash, dust, or fumigant discussed.
J.R.W.J.

Red Spider; On the control of—by means of Napthalene vaporised over a special lamp.

PARKER. *Annals of Applied Biology*, XV, No. 1, February, 1928.

Trial fumigations were carried out on carnations, which are very susceptible to attack by *Tetranychus telarius*. Particulars of dosages, temperatures, and humidity are given. Many cases of 100 per cent. mortality were obtained, while 90–96 per cent. mortality was obtained with concentrations as low as 4–5 oz. per 1000 cub. ft. With tomatoes, dosages ranging from 8.0 to 7.8 oz. per 1000 cub. ft. gave 100 per cent. mortality, with no scorching below 6.7 oz. per 1000 cub. ft. When fumigating vines it was found advantageous to spread a sheet of hessian horizontally two or three feet above the lamp to prevent a dense concentration of naphthalene immediately above it. The combined cost of paraffin for the lamp and of naphthalene is 1.4d. per 1000 cub. ft.
J.R.W.J.

***Sminthurus viridis* Lubb (Collembola); On the Economic Status and Bionomics of.**

DAVIES. *Bull. of Entomological Res.*, XVIII, Pt. 3, February, 1928.

The distribution and feeding habits of this insect are discussed, and experiments are described showing that the damage caused by it to clover is considerable. Sweeping infested areas with tarred sacks would reduce the numbers considerably, but the presence of the nurse crop prevents this being done when the seedlings are in the young, critical stage. Heavy rolling, with tarred sacks arranged in front of the roller, and chain harrowing, are recommended. J.R.W.J.

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† See also under "Woolly Aphis".

Spraying Fluids; The correct time for the application of.

BRITTON-JONES and LEES. *J. Min. Agri.*, XXXIV, No. 9, December, 1927.

The authors attempt to define more closely the various times at which fruit trees should be sprayed, the stages, which are illustrated by photographs, being termed dormant, swelling, bursting, burst, green flower, and pre-flowering, or, in the case of apple, pink. Tables show the sprays suitable at each stage for application to all the chief types of fruit. J.R.W.J.

Strawberry Investigations at Long Ashton.

BALL, MANN and STANILAND. *J. Min. Agri.*, XXXIV, Nos. 6 and 7, September and October, 1927.

The investigations revealed chiefly the importance of the strawberry aphis *Capitophorus frageriae* Theo., which has been known to attack strawberries for some years without much importance having been attached to it. The life history of the pest, and its feeding habits are described, and attention is called to its effect in reducing the yield. Remedial measures suggested include the planting of runners taken from healthy plants and free from any symptoms of attack; the dipping of all runners before planting in a solution of ½ oz. 98 per cent. nicotine in 10 gals. of water, and the spraying with this solution of any plants which subsequently show signs of attack in the spring. J.R.W.J.

Strawberry Aphis (*Capitophorous fragariae* Theo.); The effects of—on the Strawberry Plant.

BRITON-JONES and STANILAND. *J. of Pomology and Hort. Sci.*, VI, No. 2, June, 1927.

Typical deformity and its effect on yield is described. Attacked plants produce abundant flower trusses earlier than normal ones, but the resulting fruits, although more numerous than on unattacked plants, are small, mis-shapen and of little market value. Damage is caused only when the aphids attack the foliage in a young and tender state. It has been suggested that the injury may be caused by a virus carried by the aphid, and the symptoms resemble those of a supposed virus disease recorded in California. No indication of the presence of a virus was obtained, however, in the studies here described. J.R.W.J.

Swede Midge in North Wales; Some observations on the.

WALTON. *J. Min. Agri.*, XXXIV, No. 6, September, 1927.

An account is given of *Contarinia nasturtii*, Kieff., the swede midge, which was the cause of extensive damage in North Wales in 1926. The symptoms of attack are described, and reference made to severe bacterial infection which commonly followed the insect injury under damp conditions. Information is given on the effect of date of sowing on subsequent attack, and on certain indications of varietal resistance to attack. J.R.W.J.

Tar Distillate Washes; Further experiments with.

LEES AND STANILAND. *J. Min. Agri.*, XXXIV, No. 10, January, 1928.

Field trials showed that Mortegg and Carbokrimp, at strengths of 4, 8, and 10 per cent., effectively killed the eggs of *Psylla mali*, the Apple Sucker, and *Aphis pomi*, the Green Apple Aphis. The 10 per cent. wash gave a slight but consistent improvement over the 8 per cent. in the control of the eggs of Tortrix moths, the small winter moth, and of Capsids. Considerable rain following the application of 2½ and 5 per cent. Carbokrimp, after preliminary drying, lowered the degree of control both experimentally and under field conditions. It was found that the time at which Carbokrimp became dangerous to plums depended upon the strength of spray and the condition of the buds. It could not be determined by date, nor entirely by the condition of the buds, and some other method is necessary for use under field conditions. A 10 per cent. Carbokrimp is dangerous to Black Currants as soon as the buds have become distinctly swollen. J.R.W.J.

Tar-oil Wash Trials in the West Midlands, 1926–27.

JARY. *J. Min. Agri.*, XXXIV, No. 12, March, 1928.

In these trials, Tarolite and Battle's Wash were used, with Mortegg as a standard of comparison. Two di-nitro-cresol washes were also tested. The tar distillates cleared the trees of apple aphides and the apple sucker, but complete control was not obtained with the di-nitro-cresol washes. Although under laboratory conditions almost 100 per cent. mortality was obtained with the latter washes, of Winter Moth eggs, they were far less satisfactory under field conditions. None of the tar distillates can be relied on regularly to control caterpillar infestation, or Capsid Bug attack. The di-nitro-cresol washes equalled the tar distillates in covering power did not injure the trees and left no clogging residue in the spraying machinery. They, however, leave marked stains on clothes and skin. J.R.W.J.

Tetrachlorethane; The use of—for Commercial Glasshouse Fumigation.

PARKER. *Annals of Applied Biology*, XV, No. 2, May, 1928.

Of the various methods of application against the greenhouse whitefly (*Trialeurodes vaporariorum* Westw.) tested in this series of experiments, that of impregnating sacks and hanging them at intervals from the wires of the house proved most successful. It is considered that three fumigations at a dosage of 5 fl. oz. per 1000 cub. ft. at intervals of ten days should be sufficient to kill the immature stages and keep an ordinary infestation in check, provided that the house is reasonably airtight and the temperature maintained at 65° to 70°F. over a period of twelve hours. Another series of experiments showed that tetrachlorethane is of no value against Red Spider, Mealy Bug, and two species of aphids, even when used at a concentration of 20 fl. oz. per 1000 cub. ft. J.R.W.J.

Tulips; Aphides infesting—On some.

DAVIDSON. *Bull. of Entomological Res.*, XVIII, Pt. 1, September. 1927.

The alate and apterous viviparous females of *Anuraphis tulipae* Boy., *Rhopalosiphoninus tulipaella* Theo. and *Macrosiphum gei*, are described in detail. The first two are important pests of stored bulbs, and the latter attacks the aerial parts. A careful examination of bulbs received for storage, and isolation for treatment of infested bulbs is recommended. A survey of the latest measures of control is given. Essig's treatment consists of soaking the bulbs for several hours in one part 40 per cent. nicotine sulphate solution to 1,000 parts of water, or of thoroughly covering the bulbs for a like period with 2 per cent. pure " nicodust ". Aphides attacking the aerial portions should be sprayed immediately they appear with a dilute nicotine and soft soap emulsion. J.R.W.J.

Woolly Aphis* (*Eriosoma lanigerum* Hausm); Studies on the resistance of Apple to the.

Le Pelley. *J. of Pomology and Hort. Sci.*, VI, No. 3, September, 1927.

As the result of these studies it was found that Northern Spy was more resistant to attack than any of the eighteen other commercial rootstocks tested. A preliminary series of artificial infestations of fifteen commercial scion varieties indicated no immunity or high resistance to attack. First infestations on maiden trees showed no definite evidence of any interaction between stock and scion with respect to woolly aphis resistance. Seedlings obtained by crossing Northern Spy with susceptible varieties showed that the factor or factors that determine immunity are inherited and that Northern Spy is heterozygous in respect of this character. J.R.W.J.

GENERAL.

A Tour in Australia and New Zealand: Grass Land and other studies.

R. G. Stapledon. Oxford University Press.

This is a supremely interesting book. It combines to a remarkably well-balanced degree and in an attractive form discussions of technical and non-technical themes and so should appeal to a far wider public than the sub-title of the volume would suggest. While readers of this *Journal* need not be told that Professor Stapledon is always refreshing and instructive when he deals with his own pet subject of grass land, few of us have, perhaps, previously fully appreciated his conspicuous capacity for vivid presentation of themes outside the realms with which his name is usually associated. Nowhere in the book does the author rise to greater heights than in his truly realistic, philosophic and even poetic references to our dumb animals with which he closes Chapter IX. Nothing could be finer. But the peruser of this volume has not to wait thus long before being confronted with a wealth of highly entertaining non-technical reading. Neither is the technical man likely to be disappointed. He is provided with ample food for reflection.

The scope of the book, which is introduced by a very apt and racy foreword by Major Walter Elliot, D.Sc., M.P., may, perhaps, be best indicated by short references to its various Chapters:—

Chapter I is a delightful essay on *Travel and Motives of Travel.* It is essentially a plea " for every possible step to be taken to persuade and to assist people, particularly young people, to travel imperially ".

Chapter II deals with *Various Impressions and some Comparisons* between our own country, Australia and New Zealand in relation to the population and its distribution. Here also we have a discussion of means of transport, and the view is expressed that " the Old Country has been the loser by not keeping abreast of developments overseas and by neglecting to manufacture colonial models of universally used machinery and appliances ".

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* See also under " Entomology ".

Chapter III: General Agricultural Impressions and some Comparisons, deals in a general way with matters of more direct agricultural interest. Comparisons are made between climates and the factors of climate are epitomised in tabular form. The great economic importance of grass as raw material is admirably exemplified. Some shrewd observations are made as to the necessity, before schemes for small holdings are inaugurated, for full use of the best technical advice as to the best size of family holding, which must necessarily vary with prevailing conditions.

Chapter IV gives a vivid account of the essential qualities in successful settlers in the Dominions.

Chapter V: The Winning of Agricultural Lands: the Mallee of Australia, directs attention to the inevitability of lag in science in relation to practice in the reclamation of land and to the appalling waste which has resulted from crude methods of exploitation. The account of the exploitation of the Mallee scrub makes fascinating reading.

Chapter VI: The Wheat Belts of Australia: Future Developments. An account is given of arable cultivation in the wheat belts, both as such and in its relation to stock-carrying, and contains many suggestions on means of further extension of wheat areas.

Chapter VII contains an interesting resumé of *The Winning of Pastoral Lands* from bush, scrub, and swamp, involving an almost superhuman, if often ruthless, effort in their conversion into farm land.

Chapter VIII discusses *Grass and Arable-Grass Farming in New Zealand* and shows that there exists there more flexibility than in our own country in farm rotations, this being due in part to the absence of tradition but mainly to climatic conditions. This flexibility affects farming practice in many directions. There follows an account of the more intensive management of grass paddocks and of farming practice in relation to dairy stock and the fat lamb industry. The chapter closes with an interesting reference to the lucerne lands of the Marlborough district and the all-cocksfoot farming on the Banks Peninsula.

Chapter IX opens with an artistic and vivid description of the scenery of the Dominions from the botanical point of view. Then follows an account of the influences of the introduction of grazing farm stock—formerly unknown in both countries. The whole question of alien flora in relation to its introduction and distribution is presented in a most readable form.

Chapter X deals with *Recent Developments in the Management of Grass Land* and *The Need of Organisation.* It claims that wholesale grass land improvement can be achieved only by a state-wide organisation. Then follows a reference to the difference in productivity between intensively and extensively managed grass land and a discussion of the factors which govern success in the grazing and improvement of pasture.

Chapter XI. Under the subject *Grass Land and The Empire: The Need for Organised Research*, the author outlines the procedure to be adopted in tackling herbage problems and presents a number of questions which stand in urgent need of investigation.

Chapter XII, dealing with *Herbage Seed Production and the Empire*, stresses the importance of strain in various species of herbage plants. It is pointed out that the tendency is more and more to leys of longer duration, there being consequently an increasing demand for " wild " and persistent strains. Equally significant is the recent demonstration that the longest response to nitrogenous manures and the longest grazing season is to be found in leafy pedigree strains. Seed production is discussed and the procedure for securing supplies of desirable strains is elaborated.

The book closes with four Appendices.

In addition to its many other conspicuous merits the book is particularly free from blemishes. It would, however, seem as if there were an error in the figures (pp. 18 and 19) expressing the relative *Stock Units* as between England and Wales, and New Zealand. It should also have been clearly stated whether the relative stock units refer to unit areas or to the countries as a whole.

No notice would be complete without reference to the excellent photographs which Mrs. Stapledon supplied and which add much to the interest of the book.

The volume can be unreservedly recommended both for its general interest and its technical value. W.S.J.

Abstracts of Papers on Agricultural Research.

H.M. Stationery Office. Obtainable from the Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W. 1. Price, 1s. net, post free.

This publication was prepared for the Imperial Agricultural Research Conference and contains abstracts of papers by research and advisory workers in Great Britain and Northern Ireland, which were published in the year October, 1926, to September, 1927. The large volume of work summarised in this publication is presented under fourteen headings, such as soils, entomology, animal diseases, dairying, etc.

The primary purpose of the publication is to inform agricultural research and advisory workers in other parts of the Empire of the work which is being done in the mother country; the volume should, however, prove of great interest to all who are concerned with agriculture and allied industries, both at home and abroad. J.L.M.

LIVE STOCK.

Abstractors:

J. A. Frazer Roberts, M.A., B.Sc., F.R.S.E., British Research Association for the Woollen and Worsted Industries, Leeds; and A. D. Buchanan Smith, M.A., B.Sc., M.S.A., F.R.S.E., University of Edinburgh.

Afterzitzen des Rindes; Beitrag zur Kenntnis der. Ihres Bewertung als Milchzeichen und ihr Verhalten im Erbgänge.

J. Juler. *Zeit. Tierz.*, Vol. 10, pp. 377-417, 1927.

The material used in this investigation consisted of 1,472 animals, and of these 338, or 22.96 per cent., had supernumerary teats. A comparison was made between the two groups as to the number and kind of teats and the number of lactation periods. No great difference was noted in the milk and fat production of the two herds.

The inheritance of this character was also studied. The possibility of the bull transmitting the factor for the unusual udder form is discussed. The character would seem to be hereditary, the factor for normal udder form being dominant, whilst the formation of an udder with supernumerary teats appears to be due to a recessive. J.A.F.R.

Amputated, a Recessive Lethal in Cattle, with a Discussion on the Bearing of Lethal Factors on the Principles of Live Stock Breeding.

CHR. WRIEDT and O. L. MOHR. *Jour. Genet.*, Vol. 20, pp. 187-215, 1928.

Following the well known previous work of these authors, a lethal condition in Friesians is described in which calves are born with the most curious malformation of the head and limbs. The head, which is grossly deformed, gives a parrot-like appearance. The forelegs are " amputated " to the elbow-joint and the hind legs to the hocks. There is pronounced hydrocephalus. The monsters are full-term and of normal size; they die immediately after birth. In one case, however, a monster was kept alive for two days. The defect depends upon the action of a simple Mendelian recessive.

It is shown that the gene was introduced into Sweden in the early 'nineties by the bull Gallus M77, who was imported from Ostfriesland. This bull is the most prominent in the Swedish breed of Friesians, with the consequence that the gene is now very widespread.

Previously recorded lethals in cattle depending upon simple recessive factors include:—

1. The bull-dog calf of the Dexter and other breeds.
2. The similar, but less grossly deformed, condition in the Norwegian Telemark breed.
3. A defect in Friesians which results in calves with imperfect skin formation round the mouth and feet.
4. Hairlessness, described by Mohr and Wriedt, and reviewed in another abstract in this section.

   Mohr and Wriedt have discovered three further cases, as yet unpublished.

This paper includes a most useful review and discussion of lethal factors in farm livestock. The extent to which single prominent sires can influence a whole breed is pointed out, and the result is discussed in the case of the two lethals described in this paper, and the other by the same authors reviewed in this section of the *Welsh Journal* abstracts. The economic importance of lethals and semi-lethals in livestock is stressed and practical measures are suggested for preventing their spread. In addition to the obvious way of eliminating known heterozygotes, the authors suggest a plan that is of great interest to English farmers, *viz.*, that bulls should not be allowed to serve as breeders on a large scale until they have given twenty normal calves from their own daughters. It is suggested that bulls that have passed this test should be awarded special recognition when grants are made under a premium scheme. That such a drastic proposal could be put forward and shown to be not impossible of realisation indicates the extent to which scientific methods in breeding have been developed in some continental countries.

J.A.F.R.

Hairless, a New Recessive Lethal in Cattle.

O. L. Mohr and Chr. Wriedt. *Jour. Genet.*, Vol. 19, pp. 315-336, 1928.

The writers describe an abnormality occurring in Friesian cattle. Calves are born almost completely hairless, the hairs at birth being only at the very earliest stage of development. The calves are born alive, but die within a few minutes. The precise cause of death is not yet clear. The defect depends upon the action of a simple Mendelian recessive. Data are given showing that the defect was introduced into Sweden in 1902 through the prominent sire, Prins Adolph 3408, and has since become widely distributed. J.A.F.R.

"Bighead" of Horses a Heritable Disease.

B. M. Gonzalez and V. Villegas. *Jour. Hered.*, Vol. 19, pp. 159-167, 1928.

Data are presented that point to the conclusion that bighead or osteoporosis is a hereditary defect. It is suggested provisionally that it is due to the action of a simple dominant sex-linked factor.

J.A.F.R.

British Sheep; Some Aspects of the Ecology of.

J. E. Nichols. *Jour. Text. Inst.*, Vol. 19, pp. T329-T333, 1928; also *Wool Rec.*, Vol. 34, pp. 697-699, 1928.

Within the British Isles there is much variation in environment, and associated with this variation there are numerous definite types or breeds of sheep. There appears to be throughout association of type with environment, and the success of sheep breeding involves the cultivation of the suitable type for particular local conditions. Different breed responses to similar sets of conditions have been shown to exist, and it can further be demonstrated that there are susceptible periods in the life of each animal at which the influence of environmental factors can reach their highest expression.

It can be said of the British breeds in their present distribution that it is possible to define those conditions of temperature, rainfall, and altitude which are most suitable for certain types. Thus, by considering together temperature and rainfall, it may be suggested that for the Down breeds a monthly rainfall of 2 inches or under from about February to June, with a mean temperature not less than 37°F. for January and February, provides the most suitable climatic environment. For the Lowland longwools the rainfall mean may rise to about 2¼ inches, with the same temperature conditions, while for the Mountain and Moorland types the most suitable months for lambing are those during which the figures for temperature and rainfall most closely approach 40°F. and 3 inches respectively. It can also be said that generally the breeds which are most widely distributed in altitude are those which can most successfully withstand the greater number of rainy days.

J.A.F.R.

Colour Inheritance in Sheep. III. Face and Leg Colour.

J. A. F. Roberts. *Jour. Genet.*, Vol. 19, pp. 261-268, 1928.

A type of pigmentation is found in which the derivatives of the primitive outer coat, face and leg hair, kemp, and birth coat, are coloured, and the rest of the fleece practically free from colour. This is the situation found in breeds with coloured faces and legs such as the Suffolk, Shropshire, and Southdown. Kerry Hill and Welsh Mountain sheep have broken colour on the face, and Blackfaces have whole colour or broken colour.

Variations in face colour fall into three groups:—

1. Those affecting the relative proportions and distribution of coloured and white fibres.
2. Those affecting the dilution of this pigment.
3. Those affecting the precise degree of restriction of colour in the white-faced sheep, this colour being largely confined to the skin.

A further analysis of the results of T. B. Wood in his crosses of Suffolks and Dorset Horns shows that they can be explained on the basis of a two factor system. Whole coloured faces and white faces are true-breeding types. Broken coloured faces usually are not. Variations of groups 2 and 3 probably depend upon a number of factors. J.A.F.R.

Detecting Heterozygotes with X-rays.

R. T. Hance. *Jour. Hered.*, Vol. 19, pp. 481-485, 1928.

In the case of most contrasted characters dominance is the rule, but in certain cases closer examination has shown that differences do exist between homozygotes and heterozygotes, even though this difference may not be visible to the naked eye. The recognition of such differences might become in the future a matter of the utmost practical importance. It would probably not be going too far to say that a large extension of methods of distinguishing homo- and heterozygotes with certainty would revolutionise the applications of genetics and go a long way towards realising the optimistic anticipations current during the early days following the rediscovery of Mendel's work.

In mice the wild type agouti colouration is dominant to albinism and as far as ordinary examination goes dominance is complete. If mice were subjected to X-ray treatment, the hair falls out, and under certain conditions of application of the rays, the regenerated hair which then appears is white and not coloured. The exposure used in the present case was the minimum that causes the hair to fall out. It was found that while the heterozygous agouti albinos regenerated hair in which the proportion of whites to coloured was 3-4 to 1, the homozygous agoutis regenerated hair in which there were a few white fibres, but the majority were darker than normal. The agouti colour that was determined by two genes therefore appeared to be "stronger" than the agouti colour determined by one. J.A.F.R.

Domestic Animals; Growth and Development, with special reference to.

X. The relation between the Course of Growth and the Course of Senescence, with special reference to Age changes in Milk Secretion.

S. Brody. *Miss. Sta. Res. Bull.*, No. 105, pp. 64, 1927.

The age changes in milk yield were found to follow the same course as the age changes in body weight. The milk yield begins to decline some time after the maximum body weight is reached, but there is no symmetry about the maximum of age curve in milk yield. The time curve of milk secretion with the advance of the period of lactation is made up of an increasing and a decreasing segment of time rate of milk yield. Additional data on man and fowls have been introduced to substantiate the conclusion that the time rate of senescence increases exponentially with increasing age.

Appended are discussions of the limiting values for milk and egg production, the relation between total, maximum and rate of decline in milk production during lactation, equivalence charts between growth in weight and age changes in milk production, the relation between milk and fat yield and fat percentage, and historical notes relating to the mechanism of milk secretion. A.D.B.S.

European Sheep; Contribution to the Studies of the origin of.

B. KACKOWSKI. *Proc. Roy. Soc. Edin.*, Vol. 48, pp. 10-14, 1928.

The four blood groups in man are well known. Sheep fall into three groups. The corpuscles of group A are agglutinated by the serum of group O containing anti-A. The corpuscles of group O are not agglutinated by the serum of A. Group O may or may not contain anti-A. The three groups are therefore A, O-anti-A, and O. The inheritance of the groups appears to be well defined. A is dominant to the two others, and O-anti-A to O. This may indicate either multiple allelomorphs or an epistatic series.

All the wild Mouflons tested belonged to group A, as do the great majority of Polish local sheep. On the other hand, English Southdowns belong mainly to group O. It is suggested that the serological method is likely to give valuable information respecting the ancestry of domestic sheep. J.A.F.R.

Fertility of Premium Stallions; Preliminary Investigations on the.

A. WALTON and T. KEITH FAIR. *Jour. Agric. Sci.*, Vol. 18, pp. 772-777, 1928.

The breeding efficiency of the horse is much below that of other domesticated animals. The fertility of a stallion depends on two main factors (1) the number of spermatozoa ejaculated at service, and (2) the activity and viability of the individual spermatozoa. The writers examined the semen of a number of stallions to see what differences in the number, activity, and viability of the spermatozoa would explain the actual differences in fertility which they exhibit. As far as the tests go, the most significant feature is that total or partial failure to ejaculate is not an uncommon occurrence, even when the service is apparently satisfactory, and this may be a prevalent cause of low fertility. The tests will be continued. J.A.F.R.

Fowl Typhoid in Chickens; The Inheritance of Resistance to.

W. V. LAMBERT and C. W. KNOX. *Iowa State Col. Jour. Sci.*, Vol. 2, pp. 179-187, 1928.

In this paper the writers report the preliminary phases of an investigation begun with the purpose of attempting to determine whether or not it would be possible by selection to increase the resistance of chickens to fowl typhoid. The term resistance rather than immunity is used, for it is probable that no animal is completely immune to any disease. However, it seems probable that various degrees of resistance towards a given infection exist, and if so it should be possible by selection to produce a strain of fowls having a high natural resistance.

An interesting point to be observed is that the differences between the various breeds are significant. Such differences, however, are probably not representative of the breeds as a whole, but more likely represent strain differences within breeds. More information on this point is desirable.

It is interesting to note in this connection also that the chicks from the Rhode Island × White Leghorn cross are slightly more resistant than the White Leghorn chicks, and much more resistant than the Rhode Island Red chicks. This would seem to indicate a dominance of the factors for resistance carried by the White Leghorn, and, likewise, to indicate that the Rhode Island Red may carry factors for resistance that the White Leghorn lacks. A.D.B.S.

Fruchtbarkeitsuntersuchungen an Schweinen unter besonderer Berücksichtigung der Inzuchtverhältnisse.

WOLFGANG GRAF VITZTHUM VON ECKSTAEDT. *Zuchtungsk.*, Vol. 3, pp. 473-496, 1928.

From a study of the breeding records of a herd of swine in which inbreeding had been practised to a very high degree, it was found that except where the animals used had been of weak constitution no defects appeared. In the opinion of the writer inbreeding practised in the case of sound animals can only have the most advantageous results. Fertility showed variation year by year. The warmer months proved to be best for farrowing. The influence of age was also studied. This strain was at the beginning very fecund, but selection for size was practised, with the result that the high degree of fertility was lowered, more attention being paid to the production of well developed and uniform litters than to actual numbers. However, since 1925, the herd has regained something of its high fertility, due to the elimination of all but highly fecund animals from the breeding stock. J.A.F.R.

Genetical Aspects of Natural Immunity and Disease Resistance.

F. A. E. CREW. *Edin. Med. Jour.*, Vol. 35, pp. 301-404, 1928.

A very useful review of present-day knowledge on the subject.

J.A.F.R.

Guernsey Cows after the age of Two Years; Growth in weight of.

C. W. TURNER. *Jour. Dairy Sci.*, Vol. 11, pp. 265-269, 1928.

Data are presented on the change of weight with age of the Guernsey cow. It is shown that from the age of first calving at about two years until the age of maximum body weight, the course of growth can be accurately represented by an exponential equation.

J.A.F.R.

Improvement of Livestock; Report on Dr. Serge Voronoff's Experiments on the.

Min. Agric. Public. H.M. Stationery Office, London. pp. 24, 1928.

In accordance with arrangements made between the Ministry of

Agriculture and Fisheries and Dr. Serge Voronoff, of the Collège de France, a delegation consisting of:—

Dr. F. H. A. Marshall Dr. A. Walton	Cambridge.
Dr. F. A. E. Crew Mr. Wm. C. Miller, M.R.C.V.S.	Edinburgh.

visited Algeria in November 1927, there to meet Dr. Voronoff and to examine his experimental animals and records.

The Voronoff method of testis-grafting consists essentially in the implantation of pieces of testis taken from one male on to the surface of the testis of another (preferably of the same species). The scrotum is opened, the surface of the exposed testis is scarified in order to evoke a mild and aseptic local inflammation, and to promote the rapid formation of new blood connections between the testis and the implant, and on to this scarified .area pieces of testis from another animal are stitched. The operation is described in detail in an Appendix.

In March 1924, Dr. Voronoff performed this operation on a sterile seventeen-year old bull called " Jacky ". The bull was then thin and haggard and took no interest in female society. By June 27th the bull had recovered his youth and covered a cow. By March 1925, he had produced three calves, and by the end of 1926 was reported to be the sire of six more. In 1927 he began to show enfeebled reproductive powers, and in April was operated on a second time. Since then he has served four cows, all reputed to be in calf.

The considered opinion of the British delegates is that, whilst the case of " Jacky " supports the hypothesis so ably adumbrated by Dr. Voronoff, it cannot, nor can the other cases recorded by him, be accepted as a final and conclusive proof of the validity of his thesis concerning rejuvenation.

Regarding the work of Dr. Voronoff with sheep, he claims not only (1) that the quantity and quality of mutton and wool improved in the case of the rams grafted before puberty, but also (2) that this improvement in characterisation is transmitted to the generation sired by these, to both male and female offspring, by the ordinary processes of reproduction.

The conclusions arrived at on this point by the British delegates are as follows:—The claim of Dr. Voronoff to increase the body weight and wool clip of the ram by the operation of testist grafting applied to the immature animal is supported by the figures submitted and by the sheep shown to the delegates, but the conditions under which the experiments have been conducted, the inadequacy of the data submitted, and the methods of presentation of the data, exclude any possibility of forming a critical opinion.

The claim of Dr. Voronoff that the improved characteristics shown by the grafted rams are transmitted to the offspring (males, females, and castrates) involves the acceptance of a principle of heredity (the inheritance of acquired characteristics) which has not been substantiated in the realm of science and could only be so by appeal to the most critical and extensive research. These requisites have not been fulfilled in Dr. Voronoff's experiments. The results are capable of other explanations based upon established principles of heredity; for example, chance isolation of superior hereditary strains, aided possibly by (unconscious) selection.

Dr. Voronoff's claims have had wide publicity in the popular and agricultural press and have possibly been accepted by a section of the public for the most part unfamiliar with the usual criteria of scientific judgment. For this reason, and because questions of considerable scientific interest and some economic importance have been raised, it is highly desirable that the matter be put to further and more critical test in this country, where conditions are more favourable to scientific control. A.D.B.S.

Inheritance of Colour, Beard, Tassels, and Horns in the Goat.

S. A. ASDELL and A. D. BUCHANAN SMITH. *Jour. Hered.*, Vol. 19, pp. 425-430, 1928.

Colour. From an examination of the Kid Register of the British Goat Society the authors found that (*a*) black appears to be the lowest term in a series, black, chocolate, fawn, cream, cream being dominant to the others; (*b*) brown appears to be dominant to all colours of the black series, and also to red and tan; (*c*) red and tan may form a series recessive to the black series; (*d*) grey and roan appear to be dominant to the black series as well as to red and tan, but recessive to brown; (*e*) white may be dominant to all colours.

Beard. The bearded character is sex-limited, being dominant in the male, recessive in the female.

Tassels. Although the figures given support the hypothesis that the factor for tassels is dominant, the authors are of opinion that the mode of inheritance may be somewhat more complicated.

Horns. The hypothesis of Asdell and Crew (1925) that the polled condition is dominant is confirmed, some of the exceptions found by these writers being contradicted. J.A.F.R.

Meat Production; Selection for.

J. HAMMOND. *Zeit. indukt. Abst.*, Supplementband' II, pp. 789-795, 1928.

Just as size is a quantitative character and changes with age, so also do the proportions of the body; for example, a leg of mutton taken from a Suffolk lamb at birth has a higher proportion of bone to muscle than one of five months old, and still higher than one in adult life. Similarly at birth the cannon bone (metatarsal) is relatively well developed and grows least after birth, while the upper bone of the leg (femur) grows most. The muscles after birth grow to an even greater extent than the bones they surround, so that the proportion of muscle to bone increases with age, while the ratio of fat to bone increases still further. Early maturity from a meat point of view means not only weight for age but also a quick change in the proportions of the parts. Thus a leg of mutton from the early maturing Southdown breed at five months old shows a high proportion of muscle and fat to bone, whereas the leg of the later maturing Lincoln breed at the same age (and of rather greater actual weight) shows a low proportion of muscle and fat to bone.

It will be inferred that the evolution of the proportions in the British type of meat producing animal has probably been brought about by gradual changes rather than large mutations, by forcing the animals to grow, and by selecting those which develop best, thus getting accumulations of slight variations along the same line in development, associated with which is the correlation between parts having the same time of growth. It is not surprising, therefore, to find that where the inheritance of these or similar characters have been studied, they have been found to be of the multiple factor or blending kind. It would appear not unlikely that they are so multiple as to be for all practical purposes continuous variations, as in fact the character itself is during the life of the animal in continuous change. If this is so, looking for discontinuous segregation in the F_2 generations is a hopeless task in the practical breeding of farm animals, as the chances of finding the desired combination are many times less than the total number of offspring it is possible to produce. In place of this method, therefore, we would suggest selection in the optimum environment, not only as regards nutrition but also as regards other conditions such as management, particularly basing the selection on the sex which the character is exhibited to fullest extent, for meat the male, for milk and fertility the female, followed by inbreeding to the parent in which the character is most pronounced.

A.D.B.S.

Mehrzitzigkeit beim Rind; über Vererbung der.

O. A. Ivanova. *Zeit. Tierz.*, Vol. 12, pp. 119-185, 1928.

The author conducted a study on the inheritance of supernumerary teats, his material consisting of 1,385 cattle. Great variation was found to occur in the number of teats. This condition seems to be due to a dominant autosomal gene. The presence of supernumerary teats would seem to be associated with high milk yield, an increase of 15 per cent. in production having been noted. J.A.F.R.

Percentage of Fat in Milk; The Influence of Temperature and certain other factors on the.

E. Weaver and C. A. Matthews. *Proc. Amer. Soc. Anim. Prod.*, pp. 145-149, 1927.

The percentage of fat in milk is higher during the first half of winter than in any other season. It is lowest during the second half of summer. The tests are lower with higher temperature. Regression co-efficients indicate that temperature exerts more influence upon fat tests than does any other factor studied. There is considerable variation in the butter fat test which could be attributed to factors other than those included in this study. A.D.B.S.

Pig Testing. The Results of Preliminary Work on Bacon Type.

A. Calder and A. D. Buchanan Smith. *Scot. Jour. Agric.*, Vol. 11, pp. 318-325, 1928.

An account is given of a preliminary test carried out at the Pig Testing Station that has been established at the Animal Breeding Research Department, Edinburgh. Two litters, pure bred Large Whites and pure bred Middle Whites, were chosen as being representative of types marketed for bacon purposes. Eight pigs were farrowed in each litter, both of which were divided into two lots. There was a difference in age of 6½ weeks between the two litters. The four pens were reared under the same conditions of housing, feeding, and general management. The Large Whites put on weight 20 per cent. more rapidly than did the Middle Whites, and consumed approximately 14 per cent. less meal per pound of live weight. The pigs were slaughtered when they weighed approximately 190 lbs. (the Large Whites then being 26¼ weeks of age, the Middle Whites 33 weeks). The quality of the bacon was tested. The conclusion was that, of the two litters, the Large Whites gave better returns to the producer. J.A.F.R.

Pig Testing in Sweden. Results of the year 1927.

N. Hansson and S. Bengtsson. *Rept.* No. 339, *Res. Sta. for Animal Breeding, Stockholm,* pp. 53, 1928.

At the Pig Testing Station at Astorp during 1927, 59 test groups, comprising altogether 289 individuals, were slaughtered during the year. Of these, 54 groups, comprising altogether 209 swine, could be regarded as being entirely normal from a test point of view. The average results of the last year are, therefore, more favourable from every point of view than those of the preceding years, during which constant progress was shown. In spite of a reduction from year to year in the live weight, the length of carcase has been constantly increasing, whereas the thickness of the back fat has just as constantly been decreasing. As a result of this, the classification of the bacon has improved each year from a little above 30 per cent. in Class I during the first years to 47 per cent. in 1926 and 55 per cent. in the same class in 1927. Simultaneously with this improvement in the quality of the bacon produced, the food consumption per kg. gain in weight has been diminishing and is, in 1927, 0.2 food units below the average for 1923. The farm breed has, during 1927, as during preceding years, shown the quickest growth and the smallest consumption of food per kg. growth, but this is balanced by a somewhat higher loss at slaughter than the Yorkshire breed. The former consequently has a smaller yield of bacon for export. The Yorkshire breed has received the highest marks for the firmness of the back fat and for the development of the hams and the belly bacon, whereas the farm breed has been superior with reference to the length of body and the thickness and distribution of the back fat. This has resulted in 67 per cent. of the swine of this breed which have been slaughtered being placed in Class I, the corresponding figure for the Yorkshire breed being not higher than 52 per cent. However, both breeds show new and important progress, and they must still be regarded as being in the main of equal value.

By a proper choice of breeding animals, it has been possible, especially in some of the stocks, to improve considerably the quality of the bacon. The production of first class bacon for export does not, therefore, necessarily mean a reduction in the daily growth or an increase in the consumption of food per kg. of growth, but seems on the contrary to take place under more economical conditions.

The influence of the male animals tested on the qualities of their descendants is shown. In the breeding of the Farm breed, the *Jorgen* and *Anker* families mentioned last year have maintained their position with 66 and 58 per cent. respectively of their descendants in Class I, and in the Yorkshire breed the *Fanfaron, Jackson,* and *Rika* families have all rather improved their average results for last year, and now reach 56, 87, and 48 per cent. respectively in Class I. The *Nalle* family has reached the best results of the year for speed of growth and length of body, whilst the newly formed *Bero* family from Ryssbylund has reached the best classification with 88 per cent. of its descendants in Class I. Also the *Bourne Bar None* family from the same farm has shown good results.

The influence of the female animals on the work of breeding is also shown. It has thus been capable of demonstration that, when several sows are paired with the same boar, variations of the qualities of the descendants arise, which must be ascribed to the hereditary influence of the females. This makes possible a suitable first choice of the stock mothers. By means of a combined use of male animals which represent desirable qualities, such qualities are accumulated in the females of the stock, and this appears to be the quickest way of reaching good results when one starts out from the beginning with the intention of forming definite female families in the stock, and within it carries on a careful selective breeding with animals which individually represent the desired qualities.

Such a formation of families of female animals in the different breeding stocks seems to be of at least as great importance in pig breeding as in cattle breeding, and the investigations which have been made in this respect show how such families already exist in several of the breeding stocks which have shown the best results.

During a special investigation regarding the influence of the weight of the pigs at three weeks old on the yield results, it was shown that pigs which are well developed at the age mentioned grow quicker, have a smaller consumption of food per kg. of growth of also achieve somewhat more favourable classification than pigs which are a little backward at the same age. The average weight of the entire litter at the age mentioned can, however, not be regarded as influencing the future development of the pigs, excepting in so far as it is an expression of the average weight of the individuals.

The quick results in commercial practice which follow the adoption and support of a Pig Testing Station are patent to all who study this excellent report. A.D.B.S.

Sex Ratio and Frequency of Sex Combinations in Pig Litters; The Swine Herdbook as a source of data for the investigation of the.

H. C. McPhee. *Jour. Agric. Res.*, Vol. 34, pp. 715-726, 1927.

The results of a statistical study of the frequency of different litter sizes and the sex ratios in each size of litter are given, based on 3,082 litters, comprising 24,004 pigs, from the Chester White Swine Record; 2,020 litters from the National Duroc-Jersey Record, by Parkes (*Expt. Sta. Rec.*, Vol. 52, p. 629); and 909 litters, comprising 7,854 pigs born in the experimental herds maintained by the U.S. Department of Agriculture, at Beltsville, Md.

Among the Chester White pigs there were 48.5 per cent. of males, and among the Duroc-Jerseys 48.8 per cent., while the experimental herd data showed 52 per cent. Among the herdbook data there was a marked deficiency of the small and large sized litters as compared with the experimental material. There was also a much larger proportion of litters of seven and eight in the herdbook material than would be expected, as compared with the Department data. Further analysis showed that a grouping into the mean sex combinations was evident in both groups of herdbook data and just as clearly absent from the experimental data, which is considered to be due to a failure to report the actual condition of the pigs at birth. It is concluded that herdbook data are not sufficiently accurate for a study of the sex-ratio and frequency of sex combinations due to a failure to report and record accurately the sex of pigs and the size of litters at birth. A.D.B.S.

Sheep; An extreme Free-martin and a Free-martin-like Condition in the.

J. A. F. Roberts and A. W. Greenwood. *Jour. Anat.*, Vol. 68, pp. 87-94, 1928.

A case is described of a free-martin calf that represented an extreme of modification in the male direction. It differed from cases previously described in possessing a penis traversed by a urethra. The second case is that of a lamb in which the abnormality was extremely similar to that found in the typical bovine free-martin. The lamb was a twin, but the sex of the twin was not known. This case is of interest because it is generally accepted that free-martins in sheep either do not occur or only do so with extreme rarity.

A comparison is made of free-martins and developmental mammalian intersexes. J.A.F.R.

Spermatozoa; Variability in the size of.

A. Savage, W. W. Williams, and N. M. Fowler. *Trans. Roy. Soc. Canada*, Vol 21, pp. 425-451, 1927.

Wodsedalek measured the heads of the spermatozoa of bulls and found they fell into two distinct size groups. Reasoning from this, it was assumed that the larger size group contained the female determining spermatozoa.

The authors of this paper have checked up this work. Using a more careful although a different technique, they have found no evidence to support the conclusions of Wodsedalek. The spermatozoa upon which Wodsedalek based his conclusions were taken before ejaculation, whilst those used by the writers were taken after ejaculation from the vagina of the cow. This introduces the possibility of some unexpected variable, and although this work naturally casts some doubts on the results of Wodsedalek, it is by no means conclusive and indicates the need for further investigation.

A result of more immediate practical importance arises from the fact that the writers discovered a big difference between the spermatozoa of healthy fertile bulls and of less healthy decidedly unfertile ones. The sperm of the undesirable sires was uniformly smaller. This is a useful contribution to knowledge and in exceptional cases is may be the only method of detecting genital unsoundness in bulls. A.D.B.S.

Vererbungsfaktor beim Pferd; Ein neuer.

Chr. Wriedt. *Hereditas*, Vol. 10, pp. 274-276, 1928.

The author described a peculiar white spotting occurring in the coat of horses exhibited by the stallion, " The Tetrarch ", and his descendants. The investigation has shown that a simple dominant factor is here concerned, which, when present in the simplex state, produces the white spotting. Its relationship to other colours and its effect when present in the duplex state have not as yet been studied. J.A.F.R.

Sterilising Ram Lambs; Vasectomy as a method of. A comparison with Castration.

J. Quinlan. *Jour. Agric. Sci.*, Vol. 18, pp. 446-459, 1928.

Whilst the removal of the testes somewhat retards full skeletal development, vasectomy does not have this effect. A detailed description is given of the method of operation, which is best carried out when the lambs are from two to three months old. For the first twelve months after vesectomy, the testis grows normally in size and shape, though there is a gradual enlargement of the tail of the epididymis due to the accumulation of debris. About two years after vasectomy the tail of the epididymis is greatly enlarged, having become almost a third of the size of the testis. Vasectomised sheep maintain a greater weight than wethers or ewes when fully matured, and produce more wool, in these respects being equal to rams. The flesh of vasectomised sheep has the characteristic flavour of " ram mutton ", but castration of the sheep when full skeletal development has been attained, or six months before slaughter, would overcome this. J.A.F.R.

Wool Research and the Farmer.

J. A. F. Roberts. *Wool Rec.*, Vol. 34, pp. 701-705, 769-775, 1928.

1. *General Considerations.*

(*a*) In this country wool is a by-product and therefore the gap between producer and utiliser is very large. It is, however, a by-product in the sale of which the farmer is directly interested.

(*b*) The utilisation of wool depends to a certain extent on the fluctuations of fashion.

(*c*) There is probably no agricultural commodity about whose true value or use the farmer is more ignorant or of which the sale is conducted for the most part on such haphazard lines.

(*d*) Wool production offers a favourable field for research, because the characteristics of wool lend themselves to scientific analysis and because of the economic confusion mentioned.

2. *The Value of the Fleece to the Sheepbreeder.*

This depends upon six considerations:—

(*a*) The coat of the sheep must be a sufficient protection at all stages during its life.

(*b*) There is a possibility of indirect association with hardiness.

(*c*) There is the chance that association exists between mutton production and fleece production.

(*d*) Fashion in breeding standards cannot be ignored.

(*e*) General economic considerations are important.

(*f*) The weight of the fleece as well as its value to the manufacturer must be considered.

3. *Fleece Analysis.*

Accurate scientific analysis is the first step in wool research as applied to production. The unit for biological and agricultural purposes is the complete fleece, and the problem of sampling is fundamental.

The following characteristics and their quantitative determination are discussed:—

(*a*) Fleece weight.

(*b*) Kemp.

(c) Separation of other fibres.
(d) Coloured fibres.
(e) Weight per unit area, fibres per unit area, fineness, and length.
(f) Growth rate.
(g) Shape in cross-section.
(h) Crimp.
(i) Staple length and the form of the lock.
(j) Elasticity and tensile strength.
(k) Shedding, breaks, and cotting.
(l) Chemical analysis.

4. *Breed standards.*

The importance of suitable breed standards is emphasised and it is pointed out that often the selection of suitable standards is sufficient to secure great improvement. The breeder, following traditional methods, will do the rest.

5. *Heredity.*

There is little room for doubt that most of the marked differences between the fleece of sheep in a particular breed and between the fleeces, of sheep of different breeds are genetic. The essential condition for successful breeding experiments is suitable methods of analysis.

6. *Environment.*

While it is true that most of the big differences between fleeces are hereditary, there can be little doubt that small differences are affected by environmental agencies, *e.g.*, climate, food, and health. This is especially important in fine wools. Again an accurate system of fleece analysis is the prerequisite to success in devising experiments.

7. Two examples of practical wool improvement schemes are considered. The first relates to the improvement of the Welsh Mountain fleece in which the main problem is kemp, the second deals with the occurrence of coloured fibres in Down fleeces. J.A.F.R.

Zwillingsgeburten bei Pferden; Verebung von.

CHR. WRIEDT. *Zuchtungsk*, Vol. 3, pp. 455-457. 1928.

From the data presented, it would appear that, though twin births may have been recorded in the ancestry of a horse, this does not necessarily mean that the animal itself will produce twins. In the selection of stallions or mares as breeding stock, no attention should therefore be paid, as far as this matter of twinning is concerned, to the breeding records of their ancestors. J.A.F.R.

PLANT PATHOLOGY.

Abstractor:

T. WHITEHEAD, M.Sc., Ph.D., University College, Bangor.

Arum; Revised Treatment for Soft Rot of.

W. F. BEWLEY and P. H. WILLIAMS, *12th Ann. Report Expt. and Res. Station, Cheshunt*, p. 83, 1926.

The measures advocated in the Seventh Report for controlling this rot, *i.e.*, cleaning off diseased areas with a stiff brush and some blunt instrument and then steeping in a solution of Formaldehyde (1 part

Formaldehyde in 40 parts water) for from one to four hours have occasionally resulted in some damage to small or badly infected corms.

An alternative method of cleaning the corms by steeping in a solution of Mercuric Chloride for seven hours has been found efficacious and with little risk of damaging the corms.

The revised treatment, which should be applied at the end of a dormant period, is as follows:—

(1) Shake plants out of the dry soil and remove all roots close to the corm.

(2) Wash in water, using a stiff scrubbing brush and a blunt piece of wood to remove the decayed portions of the corm.

(3) Steep the corms in Mercuric Chloride solution at the rate of one ounce of Mercuric Chloride to six gallons of water for seven hours.

(4) Repot in sterilised soil, using pots sterilised by boiling water, or by steam.

(5) Place the pots in houses which have been thoroughly disinfected by spraying the floor and superstructure with Cresylic acid (1 gallon 97-99 per cent. Cresylic acid in 89 gallons of water).

(6) Care must be taken in using the solution, since Mercuric Chloride is poisonous to animals and man. T.W.

Barley; Stripe. Experiments on the Control of.

H. A. Rodenhiser. *Phytopathology*, Vol. 18, No. 3, p. 295, 1928.

The author describes experiments to control Barley Stripe caused by *Helminthosporium gramineum.*

Four liquid fungicides, *i.e.*, Uspulun 0.25 per cent., Germisan 0.25 per cent., Semesan 0.3 per cent., and Formaldehyde 1 in 320, were used at different temperatures and periods of soaking. In addition ten proprietary dust fungicides were also used at the rate of 4 ozs. per bushel.

The author found the effectiveness of the liquids depended on the temperature of the solution and on the length of the soaking period.

Uspulun and Semecsan were the most satisfactory fungicides when seed was soaked for one hour at room temperature, but Germisan was equally effective when all these substances were used for half an hour at 45°C.

Generally yields were increased as a result of treating seed with the organic mercury compounds, but Formaldehyde reduced yields in 1925.

Several proprietary dusts were very effective; two eliminating stripe entirely. T.W.

Clubroot in Relation to Soil Alkalinity.

C. Chubb. *Phytopathology*, Vol. 18, No. 3, p. 301, 1928.

Investigators have long recognised that lime used in large quantities reduced the amount of clubroot.

The author states that under the conditions of his experiment a Ph of 7.2 to 7.4 is the upper limit at which the clubroot organism causes infection. The amount of disease increases very rapidly with an increase in soil acidity. At Ph 6.0 or even above, 100 per cent. infection is possible.

Sulphur injures the cabbage plant and does not control clubroot.

T.W.

Fruit Trees; Leaf Scorch on. Part IV, The Control of Leaf Scorch in the Field. Part V, Conclusion.

T. Wallace. *Journ. Pomology*, Vol. VII, Nos. 1 and 2, 1928, p. 1—being a continuation of work reported on in Vol. VI of the *Journ. of Pomology.*

Space does not admit of an adequate abstract of this important work, which should be consulted by all fruit growers.

(1) The evidence accumulated is all in support of the view that leaf scorch results from defective nutrition. Much of it also points directly to the development of leaf scorch being brought about by unsatisfactory conditions of water supply within the tissues of the plant.

(2) The soil conditions almost invariably associated with cases of leaf scorch in the field again suggest unsatisfactory conditions of water supply. The texture is either light and open or the soil is shallow and overlies an unpervious subsoil, or drainage is poor and water logging occurs. The two former conditions favour deficient water supply in dry periods and the third condition leads to root killing, and, as is well known, only specially adapted forms can thrive under such circumstances.

(3) It is known that different classes of fruits, rootstocks, and varieties differ in their susceptibility to leaf scorch and the grower has in these a fairly wide range of choice. It has been shown that certain soil conditions are conducive to the trouble and in many cases he will be able to avoid planting where such conditions occur. On certain of these soil areas he may expect to grow fruit trees successfully by suitable manurial treatment, by the use of dung and potash manures and by avoiding excessive applications of nitrogenous materials, but on others all his efforts are likely to prove of no avail. T.W.

Gladiolus Corms; Dry Rot of.

L. M. Massey. *Phytopathology*, Vol. 18, No. 6, p. 519, 1928.

Dry Rot is an important disease of gladiolus corms in U.S.A. and Canada, and is known to occur in England, France, and Holland. All parts of the plant below ground may be infected and a stem rot attacking the lower inch or two at the surface of the soil may often be seen. This stem rot frequently causes premature yellowing of the tops, followed by drying and death. On the stored corms circular lesions occur under the outer scales. These are at first minute reddish brown spots, which increase in size, blacken and shrivel as the tissues dry up. The disease is believed to be due to a new species of Sclerotium to which the name *Sclerotium gladioli* is given. Corms become infected in the field and the rot extends during storage. Soil becomes infested from planting diseased corms and the pathogene will survive in the soil for at least five years. Wounds are not necessary before infection of corms can occur. No satisfactory method of disinfecting diseased corms has been found. Crop rotation, avoiding the use of the same ground oftener than once in four or five years, is considered to be the best method of checking dry rot. Diseased corms should be picked out in storage. T.W.

Narcissus Leaves; On an extraordinary Botrytis causing a disease of.

W. J. Dowson. *Trans. Brit. Mycol. Soc.*, Vol. XIII, Parts 1 and 2, p. 95, 1928.

The occurrence and appearance of a yellow leaf blotch disease of Narcissus found in S.W. England and N. Ireland and known to growers as " Fire " is recorded. The fungus is pathogenic only to the leaves. It is regarded as a new species and given the name *Botrytis polyblastic*.

No suggestion is offered for the control of the disease. T.W.

Red Clover; Comparative Studies of two fungi which cause Anthracnose of. (Abridged title).

K. Sampson. *Trans. Brit. Mycol. Soc.*, Vol. XIII, Parts 1 and 2, p. 103, 1928.

(1) *Kabatiella caulivora* has been recorded in eleven counties in England and Wales. Petioles, stems, and occasionally the blades of red clover are attacked, with the formation of the stem of lesions which are dark brown to black, with a lighter centre which may become hollow. The general result is one of shrivelled leaves and broken stems.

In the field, late flowering clovers were found on the whole to be more resistant than the early flowering strains. *Trifolium hybridum* and *T. repens* have been infected experimentally, but *T. incarnatum, Medicago lupulina, M. sativa*, and several other members of the Leguminosae appear to be immune. Seed artificially contaminated with the spores of the fungus gave rise to diseased seedlings.

(2) *Colletotrichum trifolii.* This species has not yet been reported outside the southern states of North America and Miss Sampson has studied the disease by inoculating plants with spores from a pure culture received from America. Stems and petioles are attacked and the lesions are usually lighter in colour and do not develop a hollow centre like those produced by the previous fungus. Seedlings raised from seed contaminated with spores from a culture developed, after three weeks, the disease on hypocotyl and cotyledons.

In addition to *Trifolium pratense* the disease has been produced on *T. incarnatum, Medicago lupulina, M. sativa*, and *T. hybridum*, the latter species showing most resistance. *T. repens* and one experiment with *T. medium* gave negative results.

No suggestions are made for the control of these diseases.

T.W.

Swedes; *Olpidium radicicolum* and the " Hybridisation Nodules " of.

A. W. Bartlett. *Trans. Brit. Mycol. Soc.*, Vol. XIII, Parts 3 and 4, p. 221, 1928.

The author's summary includes the following :—

(1) In addition to the deformities produced on the roots of cultivated conciferous plants by the attack of *Plasmodiphora Brassicae* (Clubroot) and a beetle (*Ceuthorhyncus sulcicollis*) are those known as " hybridisation nodules " and in connection with which no parasitic organism has hitherto been observed.

(2) These nodules have been met with on roots of swede, turnip, rape, kobrabi, cabbage, cauliflower, and brussels sprouts. The two characteristics apparently peculiar to these nodules are their

tendency to become green when exposed to light and the production sometimes of blanched adventitious shoots bearing leaves from the underground parts of the roots, which also turn green in the presence of light.

(3) In the finer roots of swedes and of a few cauliflowers bearing "hybridisation nodules" a chytridiaceous parasite *Olpidium radicicolum* has been constantly found, but not in the nodules themselves. *Olpidium Brassicae* was also occasionally encountered.

(4) Pot experiments have shown that, under certain conditions, the former of these organisms may be very destructive to seedling plants of swede and turnip, in a lesser degree to those of cabbage, and scarcely, if at all, to those of white mustard and garden cress. It is suggested that the gaps in the rows and partial failures in the sowings, sometimes observed in swede and turnip fields in exceptionally wet seasons, may be caused by attacks of *O. radicicolum.*

No suggestions are offered for the control of this organism.

T.W.

Strawberry. "Small-Leaf".

E. Ball and C. E. T. Mann. *Journ. Pomology*, Vol. VI, p. 109, being a section of a paper on "The Influence of some Cultural Practices on the Normal Development of the Strawberry Plant".

"Small Leaf" is used in speaking of abnormal, weak plants, the chief characteristic of which is the production of weak crowns and undersized leaves. Apart from pure weakness of stock, this condition may be produced by :—

(1) Exposure of the crowns.
(2) Water logging.
(3) Artificial damage to the roots.
(4) Damage to the crowns.

The effects of 1, 2, and 3 are the same, *i.e.*, reduction of the root system. Both 1 and 3 may be brought about by cultivation, especially when drastic measures have to be taken to keep weeds in check.

Water logging, at any rate, can be remedied by making furrows between the rows in autumn where water is known to lie on the land in winter. "Small Leaf" due to damage to crowns may be caused by the hoe in spring. It is not extensively met with, but should not be confused with the symptoms of "Red Plant". Strawberry aphis also is known to cause "Small Leaf" in strawberry. T.W.

Tomato; Thielavia Root Rot of.

P. H. Williams. *12th Ann. Rept. Expt. and Res. Station, Cheshunt*, p. 26, 1926.

The fungus is a weak parasite of the tomato, producing a brown discolouration in the cortical tissue of the root. The intensity of the disease varies with the rate of growth of the plant. Slow growing plants may be badly diseased, but an increase in the rate of growth enables the plant to resist the fungus attack. Infection is slight below 48°F., but above this it is not entirely governed by the temperature.

Any circumstance which checks the development of the plant renders it susceptible to attack by Thielavia basicola. T.W.

Wheat; Control of Bunt of—in Nebraska.

G. L. Peltier. *Phytopathology*, Vol. 18, No. 11, p. 921, 1928.

(1) No appreciable differences were noted with any of the dust treatments with respect to germination, stimulation, and winter survival, except in tests with formaldehyde, which gave a consistent and lower percentage of germination.

(2) Formaldehyde was the most effective treatment under all conditions. Of the dust treatments, applied at the rate of two ozs. a bushel, copper carbonate gave the most effective control. Corona copper carb was slightly less effective.

(3) None of the other copper or organic mercury compounds showed as great a degree of control as the copper carbonates, especially under conditions favourable for maximum bunt infection.

(4) It appears that the effectiveness of all treatments tested is lessened in varying degrees under environmental conditions favouring maximum bunt infection.

(5) Treated seed should be sown as nearly at the normal date of planting for the locality as possible. T.W.

Wheat; Attempts to Control Bunt with a Formalin-Gypsum Dust.

H. H. Stirrup and H. T. Cranfield. *Ann. App. Biol.*, Vol. XV, No. 2, p. 245, 1928.

The authors describe experiments covering a period of four years, in which attempts were made to control Bunt in wheat by dressing heavily infected seed with a dry powder composed of formaldehyde and calcined gypsum.

Good control was obtained in the first two years when clean seed, *artificially* infected with bunt spores obtained from crops of different varieties, was used. In the last two years *naturally* heavily infected seed was used and under these conditions the formalin-gypsum powder gave little or no control of Bunt.

The authors consider that the experiments provide some evidence to support the view that *Tilletia tritici* is a fungus comprising a number of biologic species. T.W.

Wheat; The Germination and Early Growth of Wheat treated with Copper Carbonate and Tillantin. R.

K. Sampson and D. Walter Davies. *Ann. App. Biol.*, Vol. XV, No. 3, p. 408, 1928.

From a review of recent literature the authors conclude that the supposed " stimulating effect " of such substances as uspulun, tillantin, and copper carbonate, is in most cases clearly to be attributed to the fungicidal properties of these compounds.

The authors have conducted critical experiments to test the influence of copper carbonate and tillantin R. on several varieties of wheat, taking precautions to eliminate as far as possible disease-producing organisms. Each compound improved the percentage germination in one experiment, but the trials as a whole gave no definite evidence of " stimulation ". The conclusion is reached that these chemicals should not at present be included in the list of plant stimulants. T.W.

Leaflets. Ministry of Agriculture and Fisheries.

The following leaflets of interest to those concerned in the control of crop diseases have been recently issued, re-written, or otherwise amended:—

No. 86.	Brown Rot of Apples. Revised, November, 1927.
No. 131.	Apple and Pear Scab. Revised, January, 1928.
No. 178.	The Downy Mildew of the Onion. Re-written, June, 1928.
No. 224.	Narcissus Cultivation. Re-written, February, 1927.
No. 245.	Crown Gall. Re-written, January, 1928.

T.W.

SOILS AND MANURES.

Abstractor:

RICE WILLIAMS, M.Sc., University College, Bangor.

Ammonium Sulphate as a direct source of Nitrogen for Apple Trees; The influence of.

M. B. DAVIES. *Sci. Agr.*, 1927, 8, 1, 41-55.

Melba apple trees were sterilised with mercuric chloride to kill nitrifying organisms attached to the roots, planted in pure ground sandstone, and supplied with a nutrient solution containing as source of nitrogen either ammonium sulphate, nitrate of soda or cyanamide. It was found that the availability of the nitrogen in ammonium sulphate could not be demonstrated but that when nitrifying organisms were present the ammonium sulphate gave as good growth response as nitrate of soda. When any of these nitrogenous compounds were applied in quantities, apparently in excess of the optimum concentration, toxic effects were observed, these decreasing in the order cyanamide. ammonium sulphate, nitrate of soda. It was concluded that ammonium sulphate becomes available on very poor sand in the presence of nitrifying organisms. R.W.

Availability of Phosphate; Influence of various Nitrogenous Fertilisers on.

J. F. FUDGE. *J. Amer. Soc. Agron.*, 1928, 20, 3, 280-293.

The availability of phosphate in soils from the nitrogen experiment plots in Alabama, Rhode Island, and New Jersey Experiment Stations was determined in a number of ways. The results obtained by all these methods agreed in indicating that physiologically basic fertilisers increased the phosphate availability, whilst acid forming fertilisers decreased it, as compared with the availability as determined on the check plots unless lime was applied. Liming greatly increased the availability of the phosphates in all plots and corrected the detrimental effect of the acid forming nitrogenous fertilisers. R.W.

Blast Furnace Slag; The Agricultural Value of Specially Prepared.

J. W. WHITE and F. J. HOLBEN. *Pennsylvania Sta. Bull.*, 1927, 218, 12.

Equivalent amounts of calcium oxide applied in the form of equally finely divided blast furnace slag and ground limestone showed in pot experiments the same crop producing value. But granulated slag at the rate of 1-5 tons per acre was not equal to 1 ton per acre of 20 mesh ground limestone for red or sweet clover production in the first year. 1 ton of the slag for corn, oats, and soya bean hay yield about 75 per cent. of the crop obtained by the use of 1 ton 20 mesh ground limestone. R.W.

Carbon Dioxide in Soil Air; Percentage of.

C. O. Appleman. *Soil Science*, 1927, 4, 241-245.

Determinations were made of the percentage carbon dioxide in the soil air during the growth of potato crops. It was found that a high percentage of carbon dioxide did not prevent the tubers from sprouting, but that when the soil carbon dioxide was greatly reduced by cultivation the backward plants showed a vigorous growth. R.W.

Composition of Farmyard Manure: The effect of Weathering and Storage upon the.

W. A. Albrecht. *Missouri Sta. Bul.*, 1927, 286.

By composting straw and leaves with a patented chemical mixture and with chemicals known to be essential for the laboratory decomposition of cellulose, rain supplying the necessary moisture, a manure was obtained which gave excellent results on wheat and had a good effect on the stand of alsike clover. The total nitrogen in the dry matter and the proportion of readily soluble nitrogen increased during the decomposition of treated straw, but in untreated straw the readily soluble nitrogen decreased. R.W.

Cyanamide; The Agricultural Value of.

New York American Cyanamide Co., 1928.

In a report and discussion of fertiliser experiments conducted by the American Cyanamide Company the unfavourable results obtained by other workers are attributed to (1) the use of old material held in storage more than a year and subsequently used as the sole source of nitrogen; (2) mixing of cyanamide in large proportions with super-phosphate without provision for the escape of the heat of reaction; (3) the application of the cyanamide in direct contact with, or in close proximity to, the seed; (4) a combination of these errors of practice. It is maintained that dicyandiamide in the proportion of about 10 per cent. of the total nitrogen does not decrease the efficiency of the fertiliser, but that conditions leading to the presence of larger proportions are to be avoided. R.W.

Liming; The Delayed Effect of.

P. E. Karraker. *Soil Science*, 1927, 24, 2, 147-148.

Pot experiments on the effect of dressings of ground limestone on the growth of lucerne showed that intervals up to two months between liming and seeding may be necessary for securing the full benefit of the liming treatment with such crops. R.W.

Nitrification of the Nitrogen of Farmyard Manure in Field Soils; A Contribution to the Study of.

C. Barther and N. Bengtsson. *Medel. Centralanst. Forsokov. Jordrbruksomradet.* (Sweden), 1928, 311, 16.

In a previous work the authors found that in the incorporation of farmyard manure into field soils only the ammoniacal nitrogen of the manure undergoes nitrification. In order to confirm these results the course of nitrification of manure which had been wholly or largely freed from ammoniacal nitrogen present by distillation with or without vacuum was investigated. The experiment was carried out in clay, sand, and humus soils. No nitrification of the higher nitrogen compounds of the manure were obtained. R.W.

Organic Matter supplied in Crop Residues.

E. E. Turk. *J. Amer. Soc. Agron.*, 1927, 19, 5, 369-380.

It is concluded that increases in crop yields resulting from the addition of crop residues are probably due largely to the benefits attending the decomposition of active organic matter rather than to the mass of residual organic matter persisting in the soil. R.W.

Peat; The Value of—as a material for the preparation of Peat Manure and Compost.

D. N. Prianishnikov. *Trans. Sci. Inst. Fert.* (Moscow), 1926, 34, 72-75.

The following scheme was adopted: (1) Acid composting with phosphates with the idea of bringing phosphates into solution; (2) alkaline composting with wood ashes or lime to transform the nitrogen of peat into available form; (3) biological composting by adding liquid manure. (1) and (2) were eventually combined and inoculated with the liquid manure. The addition of liquid manure was found to be superfluous and even the alkaline composting was not important. Within two months 10 per cent. of the nitrogen from the peat became available and 18 per cent. within six months. R.W.

Peat Soils; Fertilisation of.

H. Von Feilitzen. *Svenska. Mosskulturför. Indskr.*, 1926, 40, 3, 193-216.

As the result of a large number of experiments on peat soils the following conclusions were arrived at:—(1) Fertiliser experiments on green fodder oats in Norrland have yielded large and profitable results for the fertiliser applied. Fertilising with all three plant nutrients yielded best. (2) With oats, good results were given by phosphates, and even moderate potash applications, but the addition of nitrogen was not profitable. (3) Phosphates and potash gave large yields of turnips, but addition of nitrogen gave insignificant increases. (4) All the fertilising ingredients gave very good results on grassland. R.W.

Relative Lime needs of Sulphate of Ammonia and of Nitrate of Soda and of Different Crops.

B. L. Hartwell and S. C. Damon. *J. Amer. Agron.*, 1927, 19, 843-849.

As the result of field experiments extending over a number of years it is concluded that 4 lbs. of calcium oxide to 1 lb. of ammonium sulphate should be the basis of future liming to maintain land fertilised with ammonium sulphate at the same reaction as if fertilised with an equivalent quantity of nitrate of soda. The crop yields were about equal with the two sources of nitrogen when the same reaction was secured by suitable liming. R.W.

Soil Acidity; Nitrogenous Fertilisers and.

W. H. Pierre. *J. Amer. Soc. Agron.,* 1928, 20, 3, 254-269.

It was found that all the substances tested had some effect on the soil H-ion concentration. Sodium nitrate, calcium nitrate, and calcium cyanamide decreased it. Ammonium sulphate had the greatest effect in increasing the H-ion concentration, followed in order by ammonium phosphate, Leuna saltpetre, ammonium nitrate and urea. R.W.

Soil Colour darkened by Liming and Cropping.

Ohio Sta. Bul. 417, 1928, 26-27.

Although losses of organic matter amounting to from 8 to 27 per cent. from 1894 to 1925 are shown, soil samples from the unlimed ends of five-year rotation plots showed in 1925 a colour consistently darker than that from the same plots in 1894. No significant differences were observed in the organic matter of the limed and unlimed ends of the plots in 1925, but the limed ends were uniformly darker in colour. R.W.

Soil Organic Matter and Manurial Treatments.

J. W. WHITE. *J. Amer. Soc. Agron.*, 1927, 19, 5, 389-396.

From a brief review of the literature relating to this matter the author draws the following among other conclusions:—The use of lime with manures compensates for the temporary decrease in soil organic matter resulting from stimulated bacterial action by increasing the quantity of crop residues. Chemically equivalent quantities of caustic lime and carbonate of lime appear to have the same effect on soil organic matter. Mineral fertilisers containing nitrogen stimulate the decomposition of soil organic matter more than those not containing nitrogen. R.W.

Soil Potash; The influence of Liming on the availability of.

W. H. McINTIRE, W. M. SHAW, and K. B. SANDERS. *J. Amer Soc. Agron.*, 1927, 19, 6, 483-505.

From the results of lysimeter experiments it is inferred that whilst a neutral salt of calcium may liberate potassium to the leachings of an acid soil, the reverse effect results when supplementary additions of calcium or magnesium oxides are made. The view is expressed that one of the values of liming consists in the conservation of soluble potash additions in a form most probably available to plants yet resistant to excessive loss through normal leaching. R.W.

Solubility of Soil Nutrients; The Effect of Growing Plants on.

W. H. METZGER. *Soil Science*, 1928, 25, 4, 273-280.

This work carried out at the Kansas Experiment Station consisted essentially in the determination of the relative concentrations of bi-carbonates in the water extracts of soil samples taken (*a*) close to the roots, (*b*) at the distance of two to four inches from the roots, of a number of crops both in the field and in the greenhouse. Out of sixty-six experiments with various plants, fifty-three showed an increase in the bicarbonate solution immediately about the roots, four showed no difference between the near and farther samples, and nine showed a decreased concentration in immediate proximity to the roots. The results are considered additional evidence of a measurable solvent action of excretions of carbon dioxide from plant roots upon the soil minerals. R.W.

Sulphur; Recent Experiments of the Agromonic Research Institute on the Fertilising Action of.

E. Roux. *Compt. Rend. Acad. Agr., France.* 1928, 14, 17, 616-621.

Among the conclusions arrived at are the following :—Sulphur alone increased yields in soils rich in organic matter even when these soils contained appreciable quantities of sulphates. It is considered that the sulphur, transformed in the soil into sulphuric acid, is able to play a direct part in the nutrition of plants, but that it plays a more important rôle in soils rich in organic matter through an active bacterial mobilisation of nitrogenous reserves. A small quantity of finely divided sulphur was found capable of producing a marked fertilising action under the conditions specified by the author. R.W.

Vitamin-like Substances in Plant Nutrition.

J. F. Breazeale. *Arizona Sta. Tech. Bal.*, 1927, 16, 399-417.

The author concludes that the stimulative value of manure as shown by experiments with wheat seedlings and both the crystalloidal and colloidal fractions obtained in the dialysis of manure extract, rests largely in the black, water soluble organic matter and not in the nitrogen, phosphorus, or potassium it contains. It is suggested that many plants, in order to develop normally, require certain organic compounds in the soil that are not usually considered as plant foods, that these compounds are effective in exceedingly small amounts and that they are necessary in plant nutrition because they are one of the factors that have made the plant what it is today. The benefits both of manuring and of crop rotation may consist largely in the addition to the soil of vegetable matter which sets free in its decomposition organic compounds, vitamin-like with respect to the exceedingly small quantities in which they are effective, which are essential to the growth of plants. R.W.

AGRICULTURAL BOOKS, 1928.

The following list, prepared by the staff of the National Library of Wales, is a selection of the more important books on the science and practice of Agriculture published during the year 1928, together with a few omitted from the list for 1927. The list supplements *The Hand-List of Books on Agriculture* issued by the National Library, *third edition*, 1926, copies of which can be obtained on application to the Librarian, The National Library of Wales, Aberystwyth.

APPEL, O. The diseases of sugar beet. English ed., edited by R. N. Dowling. . . . transl. by C. Leslie Wood. London: Benn, 1927. pp. [vi], 22 col. pls. (*Text pr. on back of plates.*) ... ... 6s. 0d.

BENSUSAN, S. L. Latter-day rural England, 1927. London: Benn, 1928. pp. 222. *An agricultural tour round England* ... ... 8s. 6d.

BLACK, *Messrs.* A. & C., *Ltd., Publishers.* Black's gardening dictionary, ed. by E. T. Ellis. . . . *2nd ed.* London: Black, 1928. pp. xvi, 1288 ... 7s. 6d.

BOND, J. R., *and others.* British farmers in Denmark, by J.R.B., and other members of the Mission of Inquiry into Denmark's Agricultural Methods. Repr. from the *Daily Telegraph.* London: Benn, 1928. pp. xii, 82. map ... ... 1s. 6d.

BRIDGES, A. *and* DIXEY, R. N. Sugar beet in France, Belgium, Holland, and Germany. Oxford: Clarendon Press, 1928. pp. viii, 120. ill., pls., diags., maps, bibl. ... ... 4s. 6d.

BROOKS, F. T. Plant diseases. Oxford: Univ. Press, 1928. pp. viii, 386. front. (port.), ill., bibl. ... 21s. 0d.

BULLOCK, F. Handbook for veterinary surgeons. London: Taylor & Francis, 1927. pp. viii, 96. *A legal handbook.* ... ... 2s. 6d.

Cambridge : *University. Department of Agriculture: Farm Economics Branch.* An economic and financial analysis of fifteen East Anglian Farms, 1926-27, by R. McG. Carslaw, and W. H. Kirkpatrick. Cambridge : Heffer, 1928. pp. 18 [vi]. ... 1s. 0d.

A successful Norfolk poultry farm, 1922-26. . . by R. McG. Carslaw. Cambridge : Heffer, 1928. pp. 16, [ii]. diag. ... ... 1s. 0d.

Sugar beet in the Eastern Counties, 1927. . . by R. McG. Carslaw, C. Burgess, and G. Ll. Rogers. Cambridge : Heffer, 1928. pp. xii, 94. diags. ... ... 8s. 0d.

Carroll, T. H. J. Fertilizer problems and prospects in India. London : Nitram Ltd. [1928]. pp. 86 Gratis.

Craig, R. A. Common diseases of farm animals. . . . *4th ed. rev.* Philadelphia : Lippincott, 1927. pp. xii, 382. col. front., ill., bibl. *Lippincott's Farm Manuals* ... ... 12s. 6d.

Davis, J. R. Ainsworth-. Meat, fish, and dairy produce. London : Benn, 1924. pp. 104. *The Resources of the Empire Series. Vol. I, Pt. II* ... ... 21s. 0d.

Davis, K. C. The new agriculture. . . . *2nd ed. rev.* Philadelphia : Lippincott, [1928]. pp. iv, [ii], 494. ill., bibl. ... ... 9s. 0d.

Dowling, R. N. Sugar-beet and beet sugar. London : Benn, 1928. pp. [284]. front., pls., ill. ... 15s. 0d.

Drewitt, F. G. D. The romance of the apothecaries' garden at Chelsea. . . . *3rd ed.* Cambridge : University Press, 1928. pp. xviii, 176. front., pls., ports., bibl. ... ... 7s. 6d.

Duly, S. J. Grain. Oxford : University Press, 1928. pp. [viii], 164. pls. *Problems of importation; effect of moisture on grain; loss in weight in storage, etc.* ... ... 8s. 6d.

Emerson, F. V. Agricultural geology. . . . *2nd ed. rev.* by J. E. Smith. New York : Wiley, 1928. pp. xvi, 378. ill., diags., bibl. ... ... 16s. 0d.

Floud, *Sir* Francis L. C. The Ministry of Agriculture and Fisheries. London: Putnam, 1927. pp. [xii], 380. *The Whitehall Series.* ... ... 7s. 6d.

Foster, W. A., *and* Carter, D. G. Farm buildings. . . . *2nd ed.* New York: Wiley, 1928. pp. xviii, 358. front., ill., diags., bibl. ... ... 15s. 0d.

Fryer, J. C. F., *and* Brooks, F. T. Insect and fungus pests of the farm. London: Benn, 1928. pp. 198. bibl. *The "Farmer and Stockbreeder" Manuals.* ... ... 8s. 6d.

Garratt, G. T. Hundred acre farm. London: Longmans, 1928. pp. xvi, 142. front. ... ... 5s. 0d.

Gibb, R. S. A farmer's fifty years in Lauderdale. Edinburgh: Oliver & Boyd, 1927. pp. xii, 286. front., (port.), pls., plan ... ... 7s. 6d.

Goldschmidt, S. G. Bridle wise: a key to better hunters —better ponies. . . . with plates by L. Edwards. London: Country Life Ltd., 1927. pp. x, 162. col. front., ill., pls. ... ... 12s. 6d.

Gompertz, M. Corn from Egypt: the beginning of agriculture. London: Gerald Howe, [1928]. pp. [vi], 88. ill., map, bibl. *The Beginning of Things Series.* ... ... 2s. 6d.

Harada, Jiro. The gardens of Japan. . . . [Special Spring Number of "The Studio", 1928.] Ed. by G. Holme. London: "The Studio" Ltd., 1928. pp. viii, 180. ill., pls. ... ... 7s. 6d.

Hoare, A. H. The English grass orchard, and the principles of fruit growing. London: Benn, 1928. pp. 228. front., ill., diags. ... ... 32s. 6d.

Horlacher, L. J. Sheep production. New York: McGraw-Hill Book Co., 1927. pp. x, 418. ill. $4.00

House, C. A. Leghorn fowls, exhibition and utility: their varieties, breeding and management. London: The Poultry Press Ltd., [1927]. pp. 160. col. front., ill., pls. ... ... 2s. 6d.

Johns, H. J. The Fertilisers and Feeding Stuffs Act, 1926: with explanatory notes. London: Butterworth, 1928. pp. x, 186 ... ... 10s. 6d.

Johnson, A. T. The hardy heaths and some of their nearer allies. London: "The Gardener's Chronicle" Ltd., 1928. pp. 116. front., pls. *"The Gardener's Chronicle" Handbooks* ... ... 3s. 6d.

Jones, H. A., *and* Rosa, J. T. Truck [vegetable] crop plants. New York: McGraw-Hill Book Co., 1928. pp. xiv, 538. ill., bibl. *McGraw-Hill Publication in the Agricultural and Botanical Sciences* ... 25s. 0d.

Keeble, *Sir* F. W. Research and education in relation to practical farming. London: Nitram Ltd., 1928. pp. 28 ... ... Gratis.

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THE
WELSH JOURNAL
OF
AGRICULTURE.

THE JOURNAL OF THE WELSH
AGRICULTURAL EDUCATION CONFERENCE.

Vol. VI.

JANUARY, 1930.

28661/36.

*Published for the Welsh Agricultural Education
Conference by the University of Wales Press
Board (Cardiff) and sold by all Booksellers.*

MADE AND PRINTED IN GREAT BRITAIN BY
WOODALL, MINSHALL, THOMAS AND CO., LTD.,
PRINCIPALITY PRESS, WREXHAM.

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THE AGRICULTURAL LADDER AND THE AGE OF FARMERS.

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and
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Farming in England and Wales is a business in which there is comparatively little specialisation of human function. Practically all other productive industries, even in the Principality, provide very much greater opportunities of separating functions and tasks according to the varied capacities and interests of the persons engaged in them. In these industries the arrangement of the relations of persons in respect of varying functions within the business unit, and the proportions of persons in different departments or sections with their various functions, is a very large element in the task of the organiser. The various human elements, according to function, have still to be organised with capital if not with any great extent of land, and their relations and proportions have to be fixed. But the general character of the organiser's work is much more of the character of manipulating human beings than that of the farmer. The essential organisation of production on individual farms largely determines the relations and proportions of men, land and capital. Outside the farm, in the buying and selling markets, the farmer may have to meet and deal with economic organisations which have a predominantly human element. On the farm, especially on the farm of small area, or of small total economic capacity, the human factor in business success takes on different characteristics from those found in other industries. Here success is based largely on the combination of capacities in one person, or a very small group of persons, rather than on the suitable or necessary specialisation of function between person and person, or between persons in one section and those in another, and the proportions in which they are combined and the relations between them.

It is mere platitude that the small farmer has to be business organiser and workman; a buyer of raw materials and salesman of finished products; a capitalist and manual worker. Even under these general functions he has varied tasks. The groups of raw materials which he buys or the products which he must sell contain goods of very varied character. The manual tasks which he must undertake are of no less variety. As an efficient ploughman he will require a high physical capacity for energy output and a kind of physical and mental liveliness; but as a shepherd he may need rather the knowledge and judgment that come only of long experience, with a patience and keenness of observation which come from a quiet-mind.

There is of course a little element of specialisation in business and work on small farms; such as arises from some little selection of enterprise in relation to the situation and the capacity of land used, leading to some specialisation of product. Thus amongst the small businesses in farming there may be " sheep farms ", " dairy farms ", " mixed farms ", " market gardens ", " poultry holdings ", etc. Where transport facilities and marketing opportunities, rather than soils and natural conditions, determine the character of the major products there is clearer specialisation of this type. But by the very nature of the economic use of land, complete specialisation of production if often impossible. There must be some combinations of crops and stock to secure complete and/or economical use of resources in most of the specialised types of farming as they are carried on. A more complete and economical use of the purely human factor in the industry, even in the individual business, might be obtained if greater specialisation of production in the individual enterprise were generally possible; and the further commercialisation of agriculture in general may bring greater possibilities of economic specialisation. The increase in external resources as regards raw materials, especially in feeding stuffs and fertilisers, and the increasing power of control of crop production in relation to general condition and fertility of land, are undoubtedly tending in this direction. Development of special markets for produce, or of production for particular markets is perhaps even more important in the creation of these possibilities, but such economic developments are partly dependent on technical progress in the control and use of resources. Yet while the industry is organised in the small scale which now prevails, the requirements of the human element will be of a varied and complex character. Managers of enterprises will be required to combine in their total capacities very varied aptitudes and interests which will combine to make the total of personal capacity on which economic efficiency is founded.

The degree of specialisation of labour in agriculture varies between different areas of England and Wales. Where the larger farms exist the farmers have only or mainly managerial functions. On the smaller farms the farmer becomes in varying degrees both manager and workman. Over the country in general the proportion of employees exercising supervisory or managerial functions is very low.

But the low degree of specialisation in Welsh agriculture in particular is indicated by the Census tabulations for 1911 and 1921. There is here very much less specialisation than in England. In the first place, there is less distinction between employers and employees; and the proportion of the employers or those working on their own account (in control of businesses) in the total of persons engaged is much greater in Wales than in England. In the second place, there is much less specialisation amongst the employees. There is also, probably, a little less specialisation by sex than in England.

It has become almost customary to deprecate the idea of specialisation of function in agriculture; and to suggest that it is undesirable, if not impossible, in the form in which it has been developed in other industries. On the other hand, it is frequently suggested that there is or there should be " an agricultural ladder " by which the one-time workman may become a smallholder, " a worker on his own account " as the Census so well defines this status, and possibly eventually the occupier of a farm with sufficient business to need and use employees. The suggestion was made a century and a half ago that such a " ladder " existed, and the statement is often made at the present time that a " practicable agricultural ladder " is an urgent social necessity.

There is a good deal of confusion in these ideas and suggestions; but, most important in Great Britain, there is no clear realisation that all the suggestions of " an agricultural ladder ", whether it exists or whether it should be made, imply an age-ladder. In effect, the young man will start as an employee, for no one apparently suggests that a class of temporary employees, at least, is unnecessary or undesirable. At a later stage he will become a small farmer of the status of tenant, and then he may change his property status and become an owner; or change his industrial status and become an employer on a larger farm. Then if he is particularly fortunate or peculiarly efficient he may change his property status and become the owner of a large farm. But all these changes will tend to occur at different stages in the life of the individual. He will be older as he makes each change. Individual climbers will make different rates of progress and arrive at the various stages at different ages according to their personal capacities and the economic advantages or handicaps with which they start. Eventually, individuals will arrive and stop at different steps in the ladder. While one may climb with difficulty on to the first step, another will proceed apace to the highest rung. But with a broad ladder and full activity the process of climbing would segregate people, and determine their functions and tasks in the industry, not only according to ability but also according to age.[1] With a narrower ladder, and partial working of the process, some amount of this kind of segregation must and does take place.

Hitherto there has been no direct evidence of this phenomenon in England and Wales, but in the United States where something like the " ladder " exists, and is appreciated, the phenomenon may be seen quite clearly. " It has been found convenient to regard working as a wage-earner, as a tenant, and as an owner-farmer as successive rungs on a ladder of individual progress in agriculture. The comparison is useful in some regards, for it suggests a movement from stage to stage which constitutes an important fact in the economic life of the farming classes. We may recognise the following important steps, arranged in the usual order of progress : (1) farm wage-labourers ; (2) croppers, especially in the south ; (3) tenants other than croppers ; (4) part owners, mortgaged ; (5) part owners, free of mortgage ; (6) owner farmers, mortgaged ; (7) owner farmers, free of mortgage.[2] But in applying the analogy of the ladder to such an artificial scheme there must be a number of reservations ". " Various successive stages may not always represent progress ". " Progress in independence does not always represent progress in well being ".[3]

The ages of farmers at several of the stages mentioned above are given below.

Percentage of farmers in each age group. U.S.A. 1920.

Age group.	*Cash and share tenants.*	*Cash and unspecified share tenants.*	*Part owners.*	*Full owners mortgaged.*	*Full owners not mortgaged.*	*Total excluding managers.*
Under 25 years	**63.4***	12.4	5.0	7.6	10.2	98.6
25—34	42.7	**13.8**	8.9	17.1	16.2	98.7
35—44	28.7	11.1	**10.5**	**22.0**	26.6	98.9
45—54	21.1	9.0	9.8	21.6	37.6	99.1
55—64	14.2	6.5	7.7	19.7	51.2	99.3
65 and over	10.8	5.7	4.7	14.1	**64.1**	99.4

* Figures in black type represent the age group in each tenure class which shows the highest percentage.

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[1] See below, p. 13 and p. 15.

[2] With a well established, organised and legally protected system of tenancy it is arguable whether or not ownership is the most desirable goal.

[3] *Agricultural Year Book,* 1923, " Farm Ownership and Tenancy ", pp. 507-600.

The suggestion that there is, or should be, an agricultural ladder has many implications which deserve statement in the clearest possible form.

(1) Unless the industry is expanding or the number of independent businesses increasing the rise of any number of people from the position of employee to that of working for themselves or becoming employers, implies that an equal number of persons must suffer a decline in status or leave the industry.

The statement contains the implication that the sons of small holders and farmers have the same potential status as their fathers, or nearly so; and this is true in a general sense. They frequently inherit or receive by gift or marriage some capital and they have considerable advantages in " climbing the ladder " even if they do not set foot at the start on the rungs held by their fathers.[4]

(2) The people now enjoying the industrial and economic status of small holder and farmer (approximately the status of " working on own account " and " employer ") produce sufficient and more than sufficient sons to supply the future requirements of these classes as indicated by the present economic trends.

Not by any means all of these sons follow in their father's footsteps. The number of small holders and farmers who die or who become economic casualties is greater than the number of oncoming sons. By the efflux of sons and relatives openings are made for persons of lower economic status within the industry, or for persons from outside.

(3) The efflux of sons of small holders and farmers, mainly sons of farmers, carries with it an efflux of capital which has previously been used in the industry.

Unless the total supply of capital is to be diminished an equal amount of capital must be saved or at least brought on to the farms. Any " ladder " implies that it will be saved. There may be temporary borrowing but unless the borrowers are going " to work for the Banks " they must save eventually.

Unless there is an adequate system of credit in existence this saving must mean one of two things; either the farms used for climbing are relatively short of capital for considerable periods, or the families are kept relatively short of income for consumption purposes. The existence of the best credit system changes the probability of the occurrence of one of these conditions only in degree and does not remove it. It is safe to say that no other productive industry now saves capital under such hard conditions as those prevailing in agriculture. It is practically certain that the existence of the agricultural ladder, especially in the small-farm pastoral regions is responsible for a good deal of under-capitalisation.

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[4] In Wales some 77 per cent. of present farmers were sons of farmers. (*Social Origin of Welsh Farmers.* This *Journal*, Vol. II). In England the proportion may be 70 per cent. or higher. (Lennard, *Economic Notes on English Agricultural Wages*, p. 59).

(4) The existence of a wide " ladder " means that climbing is chiefly a process of hard saving of farming capital in order to take it out of the industry. The man who starts as employèe and becomes employer and capitalist whose children do not return to farming merely supplies capital for other industries and professions.

It may be good for the industry, even for the farming class, that it should take in " new blood ", and it is almost certainly good for society at large that there is an efflux from the farming class to other occupations. Doubt may be expressed as to whether it is good for agriculture that on the passing of each generation capital should pass out of its organisation and that every rising generation should be obliged to save capital other than that required for replenishment and increase of total supply.

(5) As regards the general possibility of climbing, and the rate at which it may be accomplished, it is necessary to remember that as a large proportion of agricultural capital is obtained by inheritance and marriage, certain people who have to save or accumulate all the capital which they use must climb with heavy handicaps. Only relatively high personal capacity can enable them to climb at all. There cannot be complete freedom of competition in climbing an agricultural ladder.

(6) The existence of a ladder also implies a good deal of mobility in the farming class. There cannot be economic climbing without a considerable amount of physical moving. There are occasions when the tenant changes his status without changing his farm. On rare occasions the employee may become the tenant of the farm on which he has been employed. If, however, climbing is from small farm to larger, the physical moving must occur with the economic climbing.

Mobility of the agricultural class is to be desired. Rigid immobility is bad for the class of farmers, and on the whole bad for society. There can be little doubt that the present class of farmers are quite as settled in the matter of residence and place of business as is desirable, and it is probable that a little more moving and broadening of experience would have good effects. On the other hand, too much movement has its own disadvantages. These are social rather than economic in character. The moving family breaks relationships with school and church, with people and societies, and if movement is frequent the family may never have any settled or satisfactory social relationships. It is significant that in the United States of America the average period of farm occupancy by free owners is only about 14 years, of mortgaged owners only 9.2 years, while the average period of occupancy by cash tenants is only 3.8 years[5], and of " share renters " 2.6 years. The average period of occupancy by tenants in England and Wales has been about four times longer than in the U.S.A. and a little longer than that of owners of American farms. Enquiries made in 1919 indicated an average period of occupancy by tenants of 15-16 years. Such stability would be entirely impossible with a ladder of any considerable width.

The complete agricultural ladder does not exist even in the United States. Of the tenants recorded in the Census of 1920, only 42 per cent. had previous farming experience only as wage-hands, while 47 per cent. had no previous experience (except possibly working on their parents' farms) either as wage-hands or as owners; some 5 per cent. had experience as both wage hands and owners; and another 6 per cent. had experience as owners. The last two figures are notable, for they indicate that the agricultural ladder, like all others, leads in two directions from any point except the extreme ends.

As regards the owners recorded in the U.S.A. Census of 1920, some 42 per cent. became owners without being either wage-hands or tenants, 14 per cent. became owners after being wage-hands only, 24 per cent. became owners after experience only as tenants, while not more than 20 per cent. went through all the stages—wage-hand, tenant, to ownership. Probably the great majority of the 42 per cent. had worked without wages on parents' farms.[6]

The processes as regards the stages passed through by both tenants and owners varied from State to State to some extent, but the above extracts represent the general processes.

The existence of an agricultural ladder in England and Wales depends upon one or more of these four conditions; (*a*) expanding area in use, (*b*) reduction in size of farms, (*c*) rapid change of status of persons within the industry, (*d*) efflux of farmers to other occupations; and in the case of (*c*) it should be noted that the " ladder " is one of ascension and descension. The industry is not expanding, and shows tendency rather to decline. The area in farms is diminishing. But the size of the industry as regards numbers of persons engaged, or engaged in any particular capacity, even as farmers, is not entirely dependent upon the area used. Increase in production, or increase in numbers of persons engaged, either in total or in a given class, may be quite consistent with a decline in total area used as shown by the figures. From 1881 to the present time the numbers of farmers have been as follows :—

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[5] Period *circa* 1910. *Agricultural Yearbook*, 1923, p. 594.

[6] *Agricultural Yearbook*, 1923, pp. 553-556.

	Males.	*Females.*	*Total.**
1881	203,329	20,614	223.943
1891	201,918	21,692	223,610
1901	202,751†	21,548	223,299
1911	208,761†	20,027	228,788
1921	244,653†	19,440	264,093

* For a convenient summary of population figures see *Agricultural Output of England and Wales*, 1925, ch. 8.

† Figures used in Table I below differ from these by omitting males under 15 years.

The figures for census years prior to 1871 are not strictly comparable with those given above. But from 1881 to 1901 the number of farmers was practically constant, there was an increase from 1901 to 1911, and a greater increase in the following decade.

At these periods the total area in use (" total cultivated land ") and the average " per farmer " and " per holding " have been as follows :—

	Total cultivated area (acres).	*Average size of farm. (T.C.A. ÷ number of farmers). (Acres).*		*Total number of " Holdings."*	*Average size of " Holding." (T.C.A. ÷ number of " Holdings ").*
1881	27,448,900	122.6	(1885)	452,000*	60.7
1891	28,002,134	125.2	(1895)	440,467	63.6
1901	27,562,314	123.4	(1903)	433,002	63.6
1911	27,248,823	119.1	(1913)	435.677	62.5
1921	26.144,071	99.0		420 133	62.2

* Figures for 1885 have been adjusted as nearly as possible. The figures in this column are of little value, but are the only ones available. For a full discussion see *Agricultural Output of England and Wales*, 1925, ch. 7 and pp. 143-144.

These figures can only be used for comparative purposes, for the average size of farms farmed for a full livelihood is not known. So far as the figures for " average size of farm " go they indicate that an increasing number of farmers working on their own account or as employers is quite consistent with a decline in acreage, and reduction in size of average farm. But the latter condition means a shortening of the ladder, broader steps but fewer steps to climb.

Evidence available for Wales indicates that there is little recruitment of farmers from outside the agricultural classes, but that there is considerable recruitment of farmers from the farm worker class. Nearly 11 per cent. of the present farmers had farm workers for fathers; and 10-11 per cent. of the present farmers had been both farm employees and sons of farm employees. But as many as 22 per cent. of the present farmers had worked as employees on farms. There may also be some other characteristics of the " ladder " movement in agricultural status by movement from one farm to a bigger or better, and by change from the status of tenant to that of owner.

From what has already been stated it might be expected that in the case of the existence of a broad agricultural ladder, the farmers of the higher economic status would tend to be those of the higher age-levels. There is no general evidence on this point, but an analysis of the age of farmer and size and rent of farm in a group of Cardiganshire farms gave a negative result. No general and direct relationship was found between the age of the farmer and the size or rental of his farm. This is in accordance with expectations arising from the investigation of the origin of Welsh farmers. But the further analysis of this group of Cardiganshire farmers indicated that the sub-group of older farmers over 55 years of age consisted of four distinct classes; (*a*) the class of occupiers of small farms who had always been occupiers of such farms and had not changed their status, (*b*) a class of occupiers of small farms to which they had retired or " retreated " from larger farms,[7] (*c*) a class of occupiers of medium and larger farms who had been in occupation of those farms throughout their business career, and (*d*) a class of farmer who had " climbed " to farms of this size. It is only for the last class that a direct positive correlation between age of farmer and size of farm would be expected; and it should be noticed that in the whole group the tendency towards negative correlation in class (*b*) would tend to balance the tendency towards positive correlation in class (*d*).[8]

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[7] There are two kinds of " retreat ". The retreat of success, and the seeking of an easier life with some occupational interest; and the retreat from partial failure.

[8] In the course of a Survey of a Carmarthenshire parish by W. H. Jones the ages of farmers were ascertained from them and checked by reference to documents, and the sizes of farms were checked. In this small area in which holdings are well graded by size the coefficient of correlation (r) between the age of farmer and size of farm was found to be r = — .25. The probable error of the coefficient of correlation = ± .06. The chances therefore are that the true r falls between — .19 and — .31. " The study fails to show the existence of a social ladder in the parish. Allowance, however, must be made for the fact that many farmers as they become advanced in years retire on to smaller holdings."

The general position is that farmers may be recruited at any age; they may then continue in farming throughout their business or occupational life, or become economic casualties, *e.g.*, become bankrupts or fail in similar ways; then they may die at any age or they may leave the industry by retiring. While remaining as farmers they may maintain a constant status in the class, ascend or descend the ladder within the class. There is some retirement of farmers in addition to loss by death and economic casualty. Very few cases of retirement before the age of 55 years occur, though farmers occasionally leave the industry to enter other business at all age levels up to 55 or 60 years. In the case of actual retirement the process may be gradual and not immediate. A farmer who is satisfied with his economic success, who does not wish the responsibility of carrying on a large farm may "retreat" to a small farm where he has occupational interest without hard work or heavy responsibility. There are also some cases of "economic retreat"; the cases of men whose capacity has not proved equal to the farms to which they attained, or who have suffered unforeseen or unavoidable loss. The group of older farmers on the small farms does not entirely represent relative failures, but contains some cases of relatively high success.

By an examination of the Census data it is possible to obtain some information about the recruitment of farmers, and by the application of the known death-rates at different ages to the Census records it is possible to obtain some idea as to how the class of farmers is constituted. If it were also possible to distribute the numbers of economic casualties according to the age at which they occur it would be possible to obtain information about the changes in the farming class with a fairly high degree of accuracy.

As regards economic casualties, bankruptcies and other financial failures, it has to be remembered that these are not always complete and final. In many cases there is a winding-up of current affairs and a re-start at a later date. The numbers of recorded bankruptcies and deeds of arrangement are not important, for over long periods they only occur at the rate of about twelve in 10,000 per annum, or twelve in 1,000 per decade. There are other financial failures, but these tend to take the character of the economic retreat of farmers to smaller farms.

The average age of recruitment of farmers is 33-34 years and it has scarcely changed in the last half century. The average age of all farmers in any recent year is 48-49 years. This has fallen by about one year since 1911 or a little later, but had previously shown a tendency to decline.

Farmers and graziers. Group as in census year.

	1901.	*1911.*	*1921.*
Average age of recruitment (Net group)* ...	33.6	33.4	33.9
Average age of recruitment (Gross recruitment) ...	33.4	33.3	33.8
Average age of farmers ...	49.7	49.3	48.2

* *Net recruitment* is the net number deducting the deaths estimated by the death-rates from the total number of males taken into the group.

Gross recruitment is the total number taken in the group without deducting deaths.

The economic importance of the age of farmers largely depends upon the size of farms they control and the type of capacity and efficiency which is required of them. On the smaller farms where muscular capacity with skill and efficiency in manual work may be a big factor in success, the highest efficiency may be reached at the age of 35, or if experience is joined with skill and efficiency, at 45 years. But where the efficiency required is of the " executive " order the higher levels may not be touched until the age of 45 is reached, and the highest levels may well be reached after attaining the age of 50.

The length of occupational or business " life " of farmers, as such, varies between one year and 60 or more years, and as many as 3 per cent. have a business life of 50 years or more. Recruitment begins at an early age, largely because of inheritance, and as many as 13 per cent. become farmers before they reach the age of 25 years; and a great number, nearly 50 per cent. of the total, become farmers when between 25 and 35 years. A number of the males who are " farmers or graziers " at ages below 21 years are not in control of farms, for the farms which are coming to them are controlled by guardians or executors. Of the total recruited at the age of 15-24 more than 80 per cent. have been recruited between the ages of 20 and 24 years.

Estimated net recruitment of farmers.

Estimated age of recruitment.	*1901.*	*1911.*	*1921.*
	Per cent. of total.		
65 and over.	1.1	—	—
55—64	0.5	0.4	0.2
45—54	8.55	8.7	11.0
35—44	27.2	28.5	29.3
25—34	49.1	49.4	46.6
15—24	13.55	13.0	12.9

It appears that in the decade 1892-1901 there was appreciable recruitment of farmers of quite high ages, but since then practically all the members of the class join it before they reach 55 years of age, and nearly 90 per cent. join it before they reach the age of 45 years. But the full statements are interesting (Table I). In the years just before 1891, and again just before 1921 there was a large recruitment of very young men as farmers. And in the decade 1912-21 there was heavy recruitment of men between 45-54 years of age, as well as a number over 55 years. The only decade in which there appears to have been recruitment of men over 65 was that of 1892-01.

So far as can be ascertained from the figures, there have been relatively few farmers who have completely retired. The losses by death are nearly sufficient to account for all the losses sustained from the gross number recruited. Of the total number of farmers recuited for the group as at 1921, it is estimated that less than 1,000 retired, and that about one third of these retired in the decade 1902-11 at between 55 and 64 years of age, and the remaining two thirds in the decade 1912-21 at over 65 years. Of the total number recruited for the group as at 1911 it is estimated that less than 400 retired in the decade 1902-11 at over 65 years of age. While from the total recruited for the group of 1901 it appears that about 800 retired in the decade 1882-91 at 55-65 years of age. It is notable that there is no direct trace of retirement in the periods of economic depression 1892-1901, while there was recruitment at fairly high ages, but this recruitment itself would hide retirements. Similarly, recruitment of older men between 1912 and 1921 would also tend to hide retirements of others. If there are any considerable numbers of final casualties from economic causes these estimated numbers of retirements must be decreased. In any case, it is clear that the number of complete retirements of farmers from business in recent decades is very small. Most farmers " die in harness ".

Alongside the group of farmers the Census records the numbers of male relatives of farmers engaged in agriculture. These are mostly males below 35 years of age, more than half the number recorded in recent Censuses were below 25 years of age. It is from this group of males that farmers are mainly recruited. But many of these male relatives pass out of the " farmer-relative class " into the ranks of employees or out of the industry altogether.

When the recruitment of the farmers and the diminution of the class of male relatives, as for the respective groups of 1921, are analysed in detail it appears that some 48,000 farmers were

TABLE I.

Constitution and estimated recruitment of groups of male farmers and graziers as at recent Censuses.*

	Recruited at age: 15–24	25–34	35–44	45–54	55–64	65 and over	*Total (actual).*	*Percentage.*
A. 1921.								
65 and over	3,025	14,139	9,660	4,941	—	—	31,765	13.0
55–64	4,587	20,883	14,258	7,213	600	—	47,541	19.5
45–54	6,059	21,579	19,196	14,674	—	—	61,508	25.2
35–44	4,524	24,224	28,454	—	—	—	57,202	23.4
25–34	4,332	33,164	—	—	—	—	37,496	15.3
15–24	8,953	—	—	—	—	—	8,953	3.6
Total	31,480	113,989	71,568	26,828	600	—	244,465	100
B. 1911.								
65 and over	2,910	14,071	11,264	3,836	—	—	32,902	15.8
55–64	3,915	18,344	12,532	6,408	—	—	41,199	19.7
45–54	4,937	22,989	15,634	7,908	—	—	51,468	24.7
35–44	6,339	22,685	20,087	—	—	—	49,111	23.5
25–34	4,673	25,005	—	—	—	—	29,678	14.2
15–24	4,392	—	—	—	—	—	4,392	2.1
Total	27,166	103,094	59,517	18,152	—	—	208,750	100
C. 1901.								
65 and over	2,627	13,145	10,260	5,279	1,040	2,287	33,598	16.6
55–64	3,691	17,818	14,273	4,860	—	—	41,682	20.6
45–54	4,392	20,586	14,066	7,194	—	—	46,238	22.8
35–44	5,333	24,267	16,573	—	—	—	46,173	22.8
25–34	6,599	23,625	—	—	—	—	30,224	14.9
15–24	4,830	—	—	—	—	—	4,830	2.3
Total	27,472	99,441	55,172	17,333	1,040	2,287	202,745	100

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* These figures show net recruitment, allowing for deaths but not for final casualties from financial causes.

recruited who could not possibly have been derived directly from the class of male relatives. This represents 20 per cent. of the total number of farmers. But most of these, over 40,000, are recruited at ages over 35 years, and some 25,000 are recruited between 35-44 years. At the age level of 25-34 years the class of male relatives is losing greater numbers than the group of farmers is taking in, but at higher age levels the farmer group takes in greater numbers than the class of relatives loses. The number of men taken into the farmer group other than from the class of relatives has been growing, for in the recruitment of the group of farmers of 1911 it only represented about 39,000 or 18 per cent. of the total. For the group of farmers as at 1901, the numbers recruited which could not have been supplied by the group of relatives amounted only to about 31,000 or about 15 per cent. of the total. A part of the recent increase is doubtless due to the operation of the Small Holdings Act, but how much cannot be ascertained. There is, of course, no evidence of recruitment from any particular outside source and other investigations would be necessary to discover the source of recruits. All that is in evidence is that the farmer group fails to maintain itself by direct recruitment from the class of male relatives who remain on farms and engaged in the industry.

There may be, of course, other changes and movements of which no indication is given by the Census and analogous records. But on the whole the indications are that the farming group is maintained as to at least 75 per cent. by recruitment from the class of relatives. Access to the control of land and capital cannot be obtained by many farm workers at ages less than 35 years. The greater number of farm workers who become small holders or small farmers to the extent of " working on own account " or of becoming employers do so at ages higher than 35 years. One important factor in the determination of the age at change of status is the time at which the older children become fit for farm work, and the age at which the strain of maintaining younger children begins to pass.

If the whole of the 50,000 farmers recruited from outside sources were taken from the groups of farm employees then in the period prior to 1921 about 9 per cent. of the total of employees would have an opportunity of becoming farmers. But the farm employees group consists of men of all ages and, as shown, the recruitment of farmers tends to occur more at certain ages than at others. If the whole of these outside recruits were taken from the class of farm workers at the ages of recruitment, then, between the age of 25 and 55, 20 per cent. of the class of farm workers would have the opportunity of becoming farmers. But the great movement of farm workers from the industry occurs at the ages 20-24, and 25-30. The movement from the class of employees at higher ages is relatively small, but is sufficient to fill the open places in the ranks of farmers if men could command the necessary capital. It is a very striking fact that when there was abnormal recruitment of farmers at ages 45-54 in the decade 1912-21 there was no abnormal loss in the group of farm employees of the same ages. The loss from this age-group of employees in this decade was not sufficient to make the number of recruits to the farmer group.

It is evident that while the group of farmers is mainly recruited from farming families, it takes in recruits from other sources, and even from outside families immediately connected with the industry. There is no direct evidence from general records of the amount of actual recruitment from the class of farm employees. Openings exist for them if they can obtain the control of capital necessary for the equipment and cultivation of farms. But while a great many relatives of farmers who stay working on farms until they reach the age of 25 and over are then obliged to seek other occupations, there must be strenuous competition for farm workers to face.

On the whole it is good for society, and probably good for the economic organisation of agriculture, that there should be recruitment of farmers from outside the families of farmers, and even from outside families connected with the industry. The chief need is that they should be equipped with the necessary technical knowledge and should have possession or command of capital. But the probability is that many of the outside recruits have less difficulty about capital than is encountered by some persons recruited within the industry itself. From the point of view of economic adaptability it is probable that insufficient recruitment from outside sources occurs. As regards farm workers, there is no doubt that greater recruitment from this class depends very largely on command of capital, and, in some districts, of suitable " rungs " in the ladder. While specialisation of function and spread of responsibility amongst employees are so much restricted, there is need of a " ladder " which will enable men to change their status and functions according to their abilities. But such a ladder can only exist as a modification of the present system. The logical result of continuing to create small holdings must be the shortening, and, eventually, the destruction of the ladder itself.

RENT AND STOCK CARRYING CAPACITY OF SOME WELSH FARMS.

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It has been a truism of economic theory that the rent of land varied, other things being equal, with its fertility, or more properly that the " economic rent " of land varied with its fertility. The classical statement is that of Ricardo : Rent is that portion of the produce of the earth which is paid to the landlord for the use of the original and indestructible powers of the soil. If, of two adjoining farms of the same extent, and of the same natural fertility, one had all the conveniences of farm buildings, and besides, were properly drained and manured, and advantageously divided by fences, while the other has none of these advantages, more would naturally be paid for the use of the one than for the other; yet in both these cases this remuneration would be called rent. But it is evident that a portion only of the money annually to be paid for the improved farm would be paid for the use of the capital which had been employed in ameliorating the quality of the land, and in erecting such buildings as were necessary to secure and preserve the produce. Whenever I speak of the rent of land, I wish to be understood as speaking of that compensation which is paid to the owner of the land for the use of its original and indestructible powers. If all land had the same properties, if it were unlimited in quantity, and uniform in quality, no charge would be made for its use, unless where it possessed peculiar advantages of situation. It is only, then, because land is not unlimited in quantity and uniform in quality, and because, in the progress of population, land of inferior quality, or less advantageously situated, is called into cultivation, that rent is paid for the use of it.[1] Malthus had defined rent as " that portion of the value of the whole produce which remains to the owner of the land, after all outgoings belonging to its cultivation, of whatever kind, have been paid, including the profits of the capital employed, according to the annual ordinary rates of the profits of agricultural capital, at the time being." Mill later stated that " the rent of land consists of the excess of its return above the worst land in cultivation," and " no land can pay rent except land of such quality or situation as exists in less quantity than the demand."

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[1] Ricardo: Principles of Political Economy.

Apart from modern extensions of the theory of rent into the factors of production other than land, the development of the theory of agricultural rent has emphasised the principle that rent is governed by the marginal productivity of land with its important corollary that rent is governed by prices of produce and not prices by rent. The practical importance of the principle to the farmer operates when he finds himself continually estimating a comparison between the net produce he can obtain from the use of one piece of land and the net produce he could obtain from the use of other and alternative pieces.

A distinction is made between the two constituents of the total or contract rent of a farm (*i.e.*, the hiring charge made for the use of the farm with all its permanent equipment) (*a*) the interest on capital embodied in equipment, *e.g.*, fences, drainage, roads, buildings, and (*b*) the element of the " economic rent " (which in individual cases, at given times, may or may not exist) which arises from differential advantages of natural origin in all the complex forms now covered by the word " fertility," or from differential advantages such as situation in relation to markets.

In farm rents an aspect of such differential advantages may also arise on the side of consumption or of living. These may be called amenity differentials. Thus farms differ in their situation relative to schools, to churches, to villages, to roads, and such differences give rise to differences in rental values, and to rents. There may be amenity differentials in economic rent. Such amenity differentials may take the form of positive and direct contributions to enjoyments or the indirect form of saving energy and expense in securing enjoyments.

Fertility depends upon the physical and the chemical conditions of the soil. The chief of these conditions are (1) mechanical structure, (2) chemical content, (3) moisture, (4) temperature of soil and air, and (5) topography. But " land " is not limited to the soil and its conditions, it includes all the " natural agents of production " such as wind and water which may be used for power or other purposes. In practice, fertility would be measured by relative physical productivity, *i.e.*, by the amounts of product (*e.g.*, bushels of grain or lbs. of meat) which can be obtained from different pieces of land with the application of the same amounts of capital and labour. The economic value of such products at the farm and consequently the economic productivity of the farm itself will be determined in part by distance from markets for produce. The economic value of produce will of course be also determined by the general conditions of the demand and supply of the market.

But in agricultural economics other concepts relating to land have gained currency. Farm land varies in its "economic capacity." That is to say, it varies in the uses to which it may be put; and in the amounts of capital and labour which may be associated with it under given circumstances with optimum results.[2] "Capacity" is measured by normal "input," or the input which under given economic circumstances secures the optimum return.

Then it is said that land varies also in its "economic efficiency." "The economic efficiency of land is measured in terms of the value of the product per unit of labour and capital expended upon it."[3] It varies in efficiency in the same way as cows. One cow consuming given quantities and qualities of feedstuffs will produce 400 gallons of milk while another with the same feed will produce 500 gallons or more. Or one engine will consume a certain amount of fuel and give a certain output of power while another with the same "input" of fuel will give a greater (or less) output of power.

Obviously economic capacity and economic efficiency of land have close relationships with the combination of physical productivity and economic productivity.

In practice the number of uses to which land may be put under a certain range of economic conditions is an important feature of its economic potentialities and of its possible rental value. There is what may be described as one-use land and multi-use land. Thus in Wales there is much land which pastorally or agriculturally has apparently, and in practice, only one use, that of sheep and wool production. Possible alternative lines of production in some cases would be of "sporting" and forestry. On the other hand there is land within a few miles of the one-use land which under certain circumstances would have many possible uses, agricultural, *i.e.*, cropping for direct sale, pastoral dairying, pastoral beef production, pastoral mutton production or combinations of these; and has within living memory had several of these uses. At the worst it could revert to the simple or lower uses of the one-use land, but it will normally continue under the more advanced or complex uses.

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[2] "The capacity of a given area of land is measured in terms of the number of units of capital and labour which can be associated with it with optimum results at a given stage of industrial progress".—Taylor, *Agricultural Economics*, Ch. 9.

[3] Taylor, *op. cit.*

All these conditions affect the rental values of farms, and to some extent the actual contract rents, or " hiring charges," and will influence whatever element of " economic rent " may exist within those amounts.

There is also another factor of considerable importance in complex systems of agriculture. The same piece of land may be worth different sums to different men. One man may use land for one purpose and obtain a certain return from the use while another might put it to a different use and get a higher return. The two men may not have the same potentialities or capacities for the use of land in the way which gives the higher return. Such differences, however, are not entirely associated with the men themselves. One may be able to associate a certain sum of capital with a given farm, and another a higher sum, when the higher will give the optimum return.

But competition is essential to the working out of effects of differences in physical productivity, in economic productivity, and in economic capacity on rentals, *i.e.*, hiring charges. Competition alone determines whether the economic rent shall be retained in whole or in part by the cultivator or be passed on to the owner. Partial failure prevents the owner obtaining the full rent unless he becomes himself a cultivator, while extreme pressure of competition may enable the owner to obtain an undue share of the products and force tenants to accept a relatively low remuneration for the use of their capital and labour.

The extent and degree of competition may vary between groups and types of farms, *e.g.*, the competition for dairy farms may be greater or less than that for sheep farms; the competition for small holdings may be greater or less than that for large farms; or the competition for " poor " farms may be greater or less than for " good " farms; or in a combination of some of these circumstances the competition in one district may be more intensive than in another. Effective competition is dependent upon possession or command of capital, and of amounts of capital required for the working of farms of given types and sizes. Control of capital, or of amounts necessary or suitable for application to farms of given types and sizes, may be restricted. There are also restrictions on competition due to the differences in capacities of farmers.

An Investigation into rents.

With some of these concepts and circumstances in view, an enquiry has been made into certain aspects of the physical productivity and rentals of Welsh farms.

The physical productivity is represented by the " stock carrying capacity " of the land reduced to the form of a stock index number which indicates the amount of livestock carried per acre. The classes and combinations of classes of livestock vary to some extent from farm to farm, and from district to district, but the stock index has been calculated by taking each class of stock, horses, cattle, sheep, pigs, and each sub-class as cows, store cattle, etc., separately and applying to them ascertained average weights (avoirdupois) in each district.

The stock index serves the same purpose as regards pastoral use of land or live stock husbandry as is served by the " crop index " in regard to arable cultivation. The crop index is a single figure which represents the yield of an area under diverse crops, measuring the yield of each crop from the average yield, or from a fixed yield of that crop, and weighting each yield per acre by the acreage represented. With mixed grazing it, is impossible to attribute definite areas to different types of stock without using detailed records of grazing. But for whole farms, or groups of farms entirely devoted to stock production it is possible to obtain an index of stock carried or produced.

The rents used are the actual rents of whole farms, including land and house and buildings. Although it would be desirable for this purpose to have rents, or estimated rentals of land, of houses and possibly of buildings separated, so that a test could be made with the whole rentals and with the rentals of land only, or of land with farm buildings, there was no practical possibility of proceeding on these lines. For purposes of local rating a separate record of estimated values of houses and buildings and of land should have been made, but this was not always done or the records were not always available. Moreover, where these estimates are made many considerations enter into the distribution of the whole rental between the two portions, and the resulting figures could scarcely be relied upon for the purposes in view. The majority of houses, however, are appropriate to the farms to which they are attached under the conditions ruling in each district. Here and there the rent of an individual farm may be somewhat affected by the attachment of an inappropriate house, one too small or too poor, or one too large for the farm. These cases do not affect the general results to any appreciable extent.

For the purpose of the inquiry records of farms were personally obtained from six districts; three in Cardiganshire, two in Caernarvonshire, and one in Pembrokeshire. In selecting these areas, the object was to have farm conditions as uniform as possible in each region so as to admit of comparison being made.

With the exception of the Pembrokeshire district, where dairying is carried on to some extent, the agriculture of the areas under consideration may best be described as mixed, but the chief concern of the farmer is the breeding and rearing of live stock.

As the area studied comprises land varying in quality from some fairly fertile soils in the valleys to the poorest kinds on the hills, it has been necessary for comparative purposes to divide the districts surveyed into two classes, viz., Highland and Lowland, which are separately dealt with in what follows. The areas comprised in such a classification are :—

Highland (mainly above 600 feet).
(1) North Cardigan.
(2) Mid Cardigan.
(3) Caernarvon.
Lowland (mainly below 600 feet).
(1) North Cardigan.
(2) South Cardigan.
(3) Caernarvon.
(4) Pembroke.

The highland district.

The highland district consists mainly of uncultivated land. A great part of it is uninhabited and it exhibits the sparse vegetation characteristic of such regions. The lower slopes generally consist of rough hillside arable and pasture land. The general character of the land and the climatic conditions do not admit of a very high standard of farming and naturally sheep and, to a less extent, cattle rearing predominate.

The sheep are of the Welsh mountain breed, but a few crossbreds are found. The sheep are marketed in store condition. Usually the breeding ewes are drafted in their third or fourth year and where wethers are kept they are sold at two and a half to three and a half years old. A small proportion of the lambs which have made poor growth are also disposed of each year. There is a growing tendency on the farms where wethers are kept to sell them at an earlier age and on others the keeping of wethers has been dispensed with and all the lambs with the exception of the ewe lambs, which are required for breeding purposes, are sold in the autumn. Some sheep are fattened, but the number marketed in this way forms only a small percentage of the total sold.

The cattle consist of Shorthorn and Welsh Black types. There is hardly any fattening done, the cattle being sold as stores at ages ranging from twelve months to two years old. Calf rearing is combined with butter making and after the needs of the farm household have been met, the surplus butter is marketed locally.

Horse breeding is not pursued to a great extent, but on some of the sheep walks a number of mountain ponies are reared.

On all the farms one or two pigs are fattened for household use and on some farms a breeding sow is kept and the progeny sold as weaners.

Poultry are unimportant, but a part of the farm income is derived from the sale of eggs and poultry.

There is only a small percentage of the land under cultivation and this occurs on the lower grounds and on the most favoured parts of the hill slopes. Oats and to a lesser extent barley constitute the cereal crops. Potatoes and swedes and, to a lesser extent, mangels form the root crops. Practically all the crops are grown for the maintenance of the farm stock.

In the Highland area the natural conditions predominate in the determination of the uses of land. The farmers have very little choice of activity although there are differences in the proportions in which cattle and sheep are combined on one farm and another. Apart from the opportunity of getting a living the farms of this area offer few advantages. Except for butter, eggs, and some pigs, practically the whole produce " goes to market on its own legs." There are differences between individual farms as regards amenities of situation, but experience suggests that the people used to farming in this area do not put high cash values on some of these amenities. Amongst the physical factors controlling the use and determining the physical productivity of land, altitude is extremely important.

Reference to Table I will show that the " input " in the form of purchased feedstuffs and fertilisers is very low. Of 180 farms, only sixty-one were using purchased feedstuffs; and these only at the average rate of about 6 lbs. per acre. About 160 farmers were using purchased fertiliser and these were using them at a mean rate of about 40 lbs. per acre. The fertilisers were practically entirely represented by basic slag, superphosphate and lime. The proportion of arable is very low, and only in twenty-five cases does it exceed 20 per cent. and in four cases 30 per cent. of the total. Still the relative proportion of arable as between some of the groups differs rather considerably. The tillage is carried on partly in the process of maintaining good pasture on the enclosed land, and partly for immediate production of arable crops. Practically all the produce of the arable land is used on the farms.

Arranging the farms in groups in order of size (Table I) it is found that on the basis of physical productivity the smaller holdings are the more heavily rented. This is a matter of common experience in Wales and it is often suggested that the proportion of total rental which should be attributed to the value of the house for residential purposes (consumption) is greater on the smaller than on the larger farms. This suggestion means, in effect, that the size of the house, and its conveniences and attractions, do not increase in proportion to the increase in size of farm. There is probably an element of truth in this suggestion, but it is not as important as it is generally thought to be. As regards farm buildings, there are generally more farm buildings, or greater capital investment in buildings, in relation to land on the smaller than on the larger farms, but in relation to live stock requiring their use there are no more buildings on the small than the larger farms. Measuring by the stock index, the higher ratio of stock to land on the smaller farms would cancel the higher ratio of buildings to land. It is evident, however, that there are considerable variations in the quality of land in farms in each of the size groups. Although there may be a tendency for the smallest and smaller farms to become established on the better land there are considerable variations in the quality of land under small farms. As measured by the stock index and rent per acre, the best land in the group of smallest farms is more than twice as good as the worst land under that group. Similarly the best land under the group of largest farms is better than the worst land under the smallest group. In each of the groups there is a great deal of variation in quality. Land is not selected for small and large farms entirely according to quality or productivity. The size of farm on any type or quality of land is partly the result of historical processes. There is an interesting comparison between the first two groups which show almost identical stock-carrying capacity, with a higher input of fertilisers in the second group, but a lower rental per unit of stock carried.

On the whole the figures indicate some influences tending to make the smaller farms dearer than the larger. There can be little doubt that intensive competition for the smaller farms is the most important of the causes at work.

Table II indicates that the stock carrying capacity rises with the rents, but as measured against stock-carrying capacity the land with lower rentals appears to be much cheaper to hire than the land with the higher rentals. Also low rents per acre tend to be associated with large farms.

When the farms are arranged according to stock carrying capacity of the land (Table III) it is still indicated that the tendency is for the lower rented land to show a relatively high stock-carrying capacity, and that the higher rented lands tend to be dearer.

On the whole, it appears that in this group of highland farms there is very considerable restriction of competition; that there is most effective competition for the small farms at all rentals per acre, and for the medium sized farms at the lower rentals; that the largest farms even at low rentals, and the medium sized farms at the higher rentals per acre do not excite intensive competition.

Lowland districts.

In the lowland districts the farmers are mainly dependent on their livestock for a living. The larger proportion of the land is under grass and most of the crops are grown for the maintenance of the stock. There is good grazing on some of the low lying lands, but few pastures are good enough to fatten cattle without the use of cake.

The breeding and rearing of cattle is an important branch of farming, and of the breeds kept, the Welsh Black and Shorthorns are most in evidence. Herefords are found in some places, but the total number is very small. The herds are mostly non-pedigree animals combining both beef and milk producing qualities, and the usual system is for farmers to maintain their herds with animals of their own rearing. There are a few farms where all the cows are bought immediately before or after calving and sold at the end of their milking period. Where this system is in practice the farmer is solely concerned with the selling of milk.

In general, calf rearing is combined with butter making. The young stock are sold at ages ranging from eighteen months to two and a half years old. Only a small percentage are fattened. It is the custom on some farms to buy cattle for winter feeding in the autumn and also in the spring for summer feeding on the pastures. Except on a few farms where milk is sold, butter is made on all the farms and is sold locally.

The sheep kept are of various kinds, Shropshires, Hampshires, Kerries, Welsh and crossbreds. The main objective is the production of fat lambs. Lambs or wethers are in same cases bought in the autumn for fattening purposes and are disposed of from November to March. These are fed on the stubbles and grass and receive in addition an allowance of oats, roots and sometimes cake.

Generally speaking, horse breeding is carried on to some extent on all the farms, but this branch of farming is usually regarded as an accessory to the working of the farm.

TABLE I.

Highland farms. (Size groupings).

Area.		*Stock Index.*			*Rent per acre.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Range.*	*Average.*	*Per 1s. of rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
Under 50	35	130–291	210	16.7	7/0–20/0	12/7	5–38	19	400	1,000	26–75	35
50– 99	72	128–302	209	22.9	4/7–15/9	9/1	3–56	19	400	1,000	6–246	85
100–149	143	95–240	168	21.1	3/9–12/9	7/11	2–28	12	460	1,436	8–170	55
150–199	174	90–201	137	17.2	2/0–12/9	8/0	1–21	9	400	1,700	6–89	37
200–249	219	98–241	150	24.4	2/9–14/8	6/2	1–25	9	400	1,762	2–88	37
250–399	316	50–164	111	32.1	1/3– 7/8	3/3	1–13	4	400	1,700	2–104	19
400 and over	821	44–143	86	33.4	6d.–11/0	2/7	1– 7	2	400	2,468	1–85	14
Average for 180 farms	295	44–302	147	23.3	6d.–20/0	6/3	1–56	9.8	400	2,468	1–246	41

TABLE II.

Highland farms. (Rent groupings).

Rent per acre.		*Stock Index.*			*Area.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Range.*	*Average.*	*Per 1s. of rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
Under 2/6	1/7	44–143	85	53.2	160–4159	965	1–4	1.6	500	2,468	1–49	10.2
2/6–4/11	3/9	68–243	117	66.3	89–972	300	1–11	4.2	500	1,737	2–104	27.6
5/–7/5	6/1	99–289	159	26.1	49–490	159	1–27	9.4	400	1,200	2–170	53.1
7/6–9/11	8/2	133–277	185	22.5	30–430	133	3–35	16.2	400	1,000	11–246	63.9
10/–14/11	11/10	58–302	204	17.2	20–1800	161	1–56	19.6	400	1,800	4–144	58.7
15/- and over	17/7	204–291	255	14.5	21–82	42	18–38	25.8	500	750	26–123	55.5
Average of 180 farms	6/3	44–302	147	23.3	20–4159	295	1–56	9.8	400	2,468	1–246	41

TABLE III.

Highland farms. (Stock Index groupings).

Stock Index.			*Rent per acre.*		*Area.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Per 1s. of Rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
Under 80	69	29.7	6d.–11/0	2/4	331–4159	890	1.0– 5	1.3	400	2,468	1–41	9
80–119	102	30.4	9d.– 7/8	3/4	100–1705	367	1.0–13.7	3.2	400	1,870	1–83	20
120–159	137	25.1	2/5–10/6	5/7	20– 620	207	1.0–27	8.3	400	1,700	6–123	43
160–199	179	22.2	3/8–13/1	8/1	30– 307	127	3.6–31	15.9	400	1,200	16–246	55
200–239	217	24.5	5/4–20/0	10/1	43– 200	111	3.1–26	16.4	400	1,126	21–180	74
240 and over	262	22.9	3/7–18/7	11/5	21– 209	71	8.3–56	24.0	400	1,285	18–133	72
Average of 180 farms	147	23.3	6d.–20/0	6/3	20–4159	295	1.0–56	9.8	400	2,468	1–246	41

Breeding sows are kept on practically all the farms and the progeny are sold as weaners or as porkers or baconers. The sale of poultry and eggs is a feature of the farming practice on all the farms.

Oats constitute the chief cereal crop, and the farmer depends mainly on this for the maintenance of his stock. Very little of the crop is sold. There is a fair acreage under barley and it does remarkably well in some of the coastal districts, but the quality is not good enough for malting purposes. It is nearly all consumed on the farms and barley meal is fed largely to cattle and pigs. Wheat is cultivated to some extent, but is not such an important a crop as oats and barley. With the exception of the wheat required for household use and for seed, practically all of it is fed to the stock. Potatoes are grown, but only a small proportion of the crop is sold. The usual custom is to retain some for household use and for seed and to feed the remainder to the pigs.

There is a fair acreage under swedes, because of their value as winter feed for cattle and sheep. Also rape is grown in some of the districts. The acreage under mangels is not very great.

Of the 135 farms, all but seven were applying artificial manures. The dressings, mainly composed of superphosphate, lime and basic slag, averaged 82 lbs. per acre with variations from nine to 540 lbs. About 50 per cent. of the farms used purchased feed and for these the quantity fed averaged 25 lbs. per acre.

The arable area represents 20 per cent. of the total land. In this respect great variations are shown between the individual farms. The lowest was 3.2 per cent and the highest 45.9 per cent. The farms under 50 acres averaged 23 per cent. and those of 200 acres and over only 12 per cent. On the holdings of over 50 and under 200 acres, the group averages do not show very wide variations and the land under the plough ranges from 19 to 22 per cent. of the total. The chief object is the rearing of livestock and the arable farming is in general subsidiary to this.

In Table IV the farms have been classified according to size. The results indicate a slight tendency towards smaller stock carrying capacity per shilling of rent as we move from the smaller to the larger farms, so that in this respect the larger farms may be thought of as more expensive than the smaller. The tendency is, however, so slight that it may possibly be due to the method of grouping or other casual causes, so that it cannot be stressed.

The results shown in Table V confirm the findings for the Highland farms, *e.g.*, that on the basis of stock carrying capacity the land with lower rentals appears to be cheaper to hire than the land at higher rentals although there is an increase in the stock index as the rent rises. The last group (25s. and over) is an exception, but probably this is not a representative sample as the number of cases in the group is very small.

Table VI indicates that when the farms are arranged according to stock carrying capacity, there is a tendency for the lower rented land to show a higher stock index per shilling of rent than the higher rented land, that is, a tendency for the higher rented land to be the dearer. This is a similar tendency to that shown by the highland farms.

In the lowland group the ranges of rent per acre and stock index for individual farms are very much smaller than in the highland group. In this sense the group is less heterogenous than the highland. It is less heterogenous also in the matter of size of individual farms, but this follows to some extent the more equal quality of the land. And it is worthy of note that the tendency for the smaller farms to become established on the better land is less marked in the lowland than in the highland group. Although the land at the lower rentals tends to be under the larger farms, it is remarkable that there are some small farms in every sub-group of the rental groupings. On the whole there appear to be very considerable restrictions on the working of competition in these groups of farms. These restrictions, apparently, are not in favour of any particular group of farms except for a slight general tendency for the land at the lower rentals to be cheaper than the land at the higher. But some individual small farms and some individual large farms are cheap relative to conditions over the whole group, and some individual small, and some large farms are relatively dear. On the whole rents are much better adjusted to stock carrying capacity in the highland than in the lowland group.

Amidst the more complex conditions in the lowland group there may be some factors such as variations in the proportions of arable, the variations in the use of purchased fertilisers, and to a less extent of feed stuffs, which counteract the influence of natural productivity on rents to a considerable extent.

The extent of use of purchased fertilisers seems to be very largely an individual matter. In the Tables below there is no regularly marked connection between amount of fertiliser used and size of farm, or rent per acre, or stock carrying capacity. While the sub-group at the highest rent shows the greatest use of fertiliser (Table V), the two groups of smallest farms when

TABLE IV.

Lowland farms. (Size groupings).

Area.		*Stock Index.*			*Rent per acre.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Range.*	*Average.*	*Per 1s. of rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
Under 50	31	230–452	327	19.2	8/2–28/10	17/0	9.0–46	23	0	700	25–165	70
50– 74	63	210–499	382	21.9	7/5–28/0	17/5	6.4–39	21	0	700	9–533	97
75– 90	86	208–426	313	21.8	7/8–25/1	14/4	3.2–46	22	0	600	23–380	79
100–124	111	183–483	323	21.2	7/0–22/1	15/3	10.3–30	21	0	600	11–275	78
125–149	135	232–565	316	20.0	8/9–24/0	15/9	2.0–29	19	30	650	18–269	77
150–199	159	147–491	297	17.5	9/0–20/3	16/11	6.6–30	21	0	600	12–400	90
200 and over	260	139–358	245	20.1	5/4–26/0	12/2	3.3–23	12	0	600	10–540	77
Average of 135 farms	118	139–565	318	20.6	5/4–28/10	15/5	2.0–46	20	0	700	9–540	82

TABLE V.

Lowland farms. (Rent groupings).

Rent per acre.		*Stock Index.*			*Area.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Range.*	*Average.*	*Per 1s. of rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
5/–9/11	8/1	139–367	245	30.6	37–350	169	2.0–46	14	0	700	10–189	41
10/–14/11	12/8	150–491	320	25.3	20–420	118	4.3–46	21	10	700	23–275	93
15/–19/11	17/2	147–499	347	20.2	21–327	106	3.2–40	22	0	600	11–400	69
20/–24/11	20/11	187–565	361	17.3	44–266	117	6.4–30	21	0	600	21–164	62
25/- and over	26/9	228–421	355	13.2	45–200	83	8.8–25	13	0	480	9–540	119
Average of 135 farms	15/5	139–565	318	20.6	20–420	118	2.0–46	20	0	700	9–540	82

TABLE VI.

Lowland farms. (Stock Index groupings).

Stock Index.			*Rent per acre.*		*Area.*		*Per cent. of arable.*		*Range of altitude.*		*Purchased fertilisers in lbs. per acre.*	
Range.	*Average.*	*Per 1s. of Rental.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Range.*	*Aver.*	*Low.*	*High.*	*Range.*	*Aver.*
Under 200	169	16.0	5/4–20/0	10/7	100–350	213	3.5–22.5	10.7	0	500	12–540	80
200–249	230	17.9	7/0–25/0	12/10	25–430	149	3.3–28.7	16.0	0	650	9–200	28
250–299	278	20.3	7/5–23/3	13/8	20–327	120	2.0–39.2	18.7	14	600	11–254	72
300–349	325	20.2	8/2–26/0	16/1	23–205	103	6.4–46.0	21.7	0	700	11–275	66
350–399	371	20.6	10/6–28/0	18/0	21–266	108	10.0–43.1	23.5	0	600	9–400	109
400–449	415	23.5	10/3–28/10	17/8	45–140	85	8.8–31.9	23.0	0	700	25–533	132
450 and over	492	25.8	11/6–24/0	19/0	23–174	78	15.8–27.0	22.0	50	600	29–261	103
Average of 135 farms	318	20.6	5/4–28/10	15/5	20–420	118	2.0–46.0	20	0	700	9–540	82

grouped by size show little more than average use of fertiliser (Table IV).

Amenity values probably show greater variation in the lowland than in the highland group; or possibly a more accurate statement would be that lowland farmers show more variations in their valuations of amenities than farmers in the highland group. If this is the case a part of the effect of competition is transferred from production values to amenity values of which no measure is obtained. In any case, the results of statistical investigation given below, where the co-efficient of correlation between rent per acre (X) and stock index (Y) equals only + .391 ± .049, would appear to indicate the existence of some restrictions on competition, or at least on the fixing of actual rents on the basis of stock carrying capacity.

The general results appear to be :—

(1) That the lower rented land tends to show relatively high stock carrying capacity. This is shown not only within each of the main groups, but between the two main groups themselves.

(2) The tendency for the smaller holdings in the highland group to be highly rented in relation to stock carrying capacity.

(3) The indication of restrictions on competition in the highland group as indicated by (1) and (2) above, and the indication of very considerable restrictions on competition as regards productive values only in the lowland group.

The relation of rents to the other factors of production is a matter for more exhaustive study when data becomes available.

STATISTICAL.

Rents per acre (X) and stock index (Y).

Some preliminary statistical investigation into the relationship, if any, between rent per acre (X) and stock index (Y) for 169 highland farms and 184 lowland farms respectively has been undertaken with the results tabulated below.

The data in respect of these different farms shows that much care is needed in interpreting the calculated constants. The text including tables will have suggested difficulties which must arise in studying together farms which, in respect of such distinguishing characteristics as total acreage, percentage of arable, capital investment, etc., are to some extent heterogenous. The three alternative groupings in the preceding text are, of course, attempts to meet difficulties of such a nature.

Rents per acre (X) and stock index (Y) were grouped in correlation tables for highland farms and lowland farms respectively and the regression lines graphed in the usual way. The calculations of the probable errors is, of course, based upon the usual assumptions.

HIGHLAND FARMS.

(1) *Coefficient of correlation.*

$$r_{xy} = + .778 \pm .02$$

Indicates a fairly high degree of positive correlation between rent per acre and stock index; a value of r equal to unity would indicate perfect correlation and very strongly suggest a causal connection between the series of data studied.

(2) Corresponding movements in " Rent per Acre and Stock Index " as we move from farm to farm are of course not necessarily solely due to an underlying relationship between these variables; such movements may be due to the association of these variables with some other variables, such as altitude, input of raw materials, input of labour, etc. Perhaps the most imporant of these factors, in the highland group, is that of altitude. The partial correlation coefficient $_ar_{xy}$ eliminates the disturbing effects of varying altitudes of the farms studied. That is, assuming the altitude of all the farms considered to remain constant the value of r becomes + .637 ± .031; a somewhat reduced value but still one which indicates fairly marked correlation. Whereas in the process of deducing the correlation coefficient it has to be assumed that a simple linear relationship exists between the variables, the correlation ratios are generalised coefficients which measure the approach towards a curvilinear line of regression of any form.

(3) The close approach of the values of the correlation ratios to that of the correlation coefficient points to a linear relationship between rent per acre and stock index. Such is, of course, the simplest form of relationship.

The closeness of fit of the graphed regression lines to the plotted values indicates such a linear relationship between rent per acre and stock index. The striking deviations of actual values from values estimated from the regression equation occur chiefly in the higher ranges of values, *i.e.*, in the upper half of the graph. These decrepancies are doubtless due to the heterogenous nature of the farms as indicated in the rent grouping Table (II), but as shown more sharply in the original data.

(4) These equations tell us that:—

(i) A rise of one in stock index corresponds on an average to a rise of .055/- in rent per acre.

(ii) A rise of 1/- in rent per acre corresponds on an average to a rise of 10.74 in stock index.

(5) These probable errors give one some idea as to the correspondence between the values of X and Y actually occurring and the estimated values of X and Y obtained from substitution in the respective regression equations. Compare the closeness of fit of observed values to the graphed regression lines.

LOWLAND FARMS.

(1) *Coefficient of correlation.*

$^{r}xy = + .391 \pm .049$

Indicates no marked correlation.

FIG. 1.

Correlation between stock index and rent per acre for certain highland farms in Wales.

Lines of regression r = + .773 (Table I).

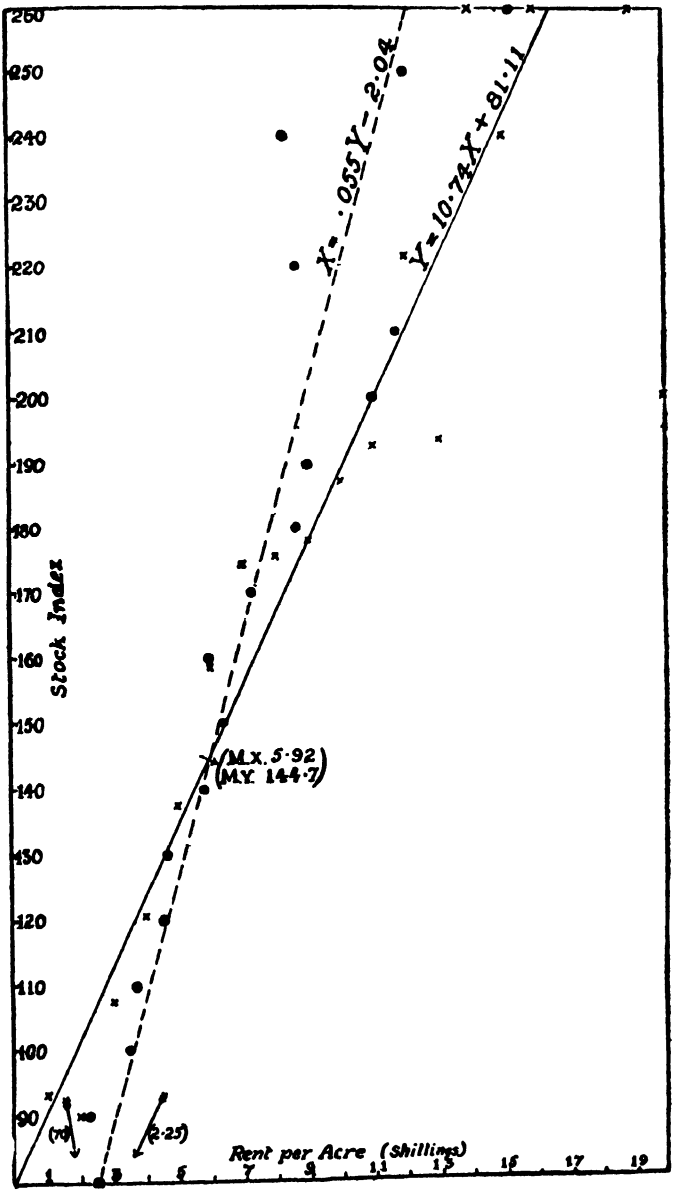
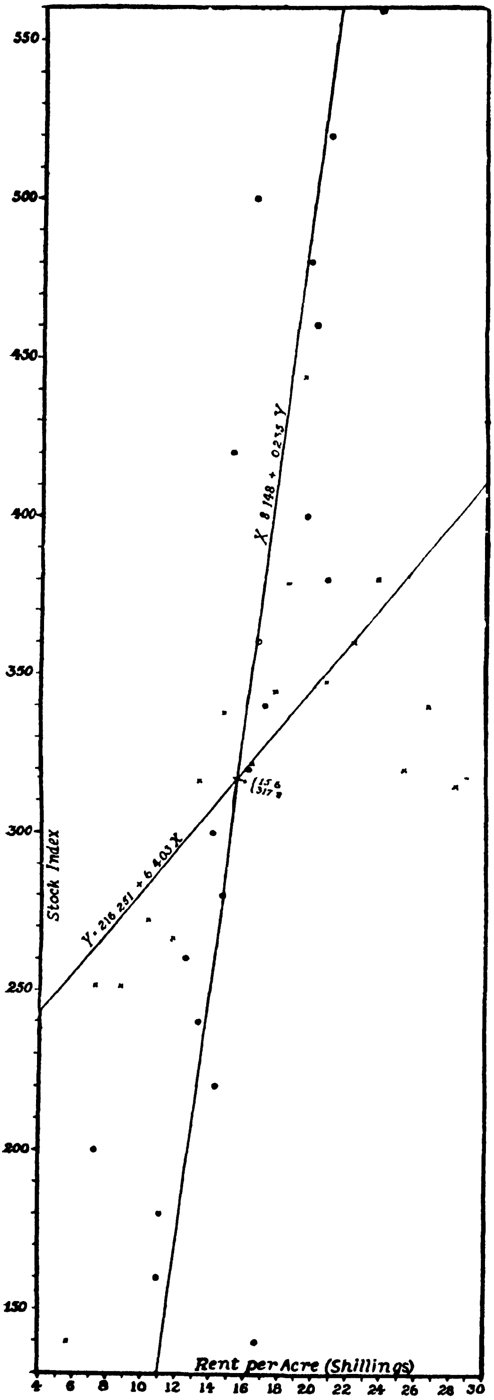


FIG. 2.—Correlation between stock index and rent per acre on certain lowland farms in Wales.—Lines of regression r = + ·391 (Table II).



(2) The result of allowing for variations in the percentage of arable land as a third factor is to reduce the correlation coefficient from + .391 to + .372.

(3) The considerable differences in the values of the correlation ratios and the value of the correlation coefficient are what one would expect from the poorness of fit of actual values to the graphed regression lines. So that in this case one is hardly justified in assuming a simple linear relationship between the variables.

(4) These equations tell us that :—
  (i) A rise of one in stock index corresponds on an average to a rise of .024/- in rent per acre.
  (ii) A rise of 1/- in rent per acre corresponds on an average to a rise of 6.493 in stock index.

(5) As with highland group, *q.v.*

General conclusions.

The results obtained for the highland group indicate a fairly high degree of positive correlation between stock index and rent per acre, and in this respect, generally support the inferences made from the grouped tables, *i.e.*, high rents and high stock carrying capacity usually occur together and conversely. Some support is thus given to the theory of rent; stock carrying capacity, other things remaining equal, being obviously some indication of the fertility of farms.

Correlation between rent per acre (X) and stock index (Y).
Statistical constants with probable errors where given.

		Highland farms.	*Lowland farms.*
(1) Coefficient of correlation ...	r_{xy}	+ .773 ± .02	+ .391 ± .049
(2) Partial correlation coefficient :			
(*a*) Altitude constant ...	${}_ar_{xy}$	+ .637	
(*b*) Percentage arable constant ...			+ .372
(3) Correlation ratios	η_{xy}	.83 ± .016	.531 ± .038
	η_{yx}	.78 ± .020	.545 ± .041
(4) Regression equations ...		X = .055 Y — 2.04	X = 8.148 + .0235 Y
		Y = 10.74 X + 81.11	Y = 216.251 + 6.498 X
(5) Probable errors in using regression equations to estimate ...	X from Y	1.55/-	3.17/-
	Y from X	21.52	52.61

With the lowland farms no such inference can be made. Possibly a larger sample would have given a different result. But in either case the sizes of the samples are such that the value of r obtained is possibly an accidental result, though that is very improbable; so that in either case too great stress should not be laid upon the results. However, reference to the nature of the sample occurs in the text.

HORSE LABOUR ON WELSH FARMS.

1871-1927.

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A study of the task per unit of manual labour on the farm at different periods in Wales showed that over the period 1871-1921 the efficiency of labour per hour had increased by about 40 per cent.[1] An examination of manual labour on the farm does not, however, give a complete picture of farm labour organisation. Farm work is carried out by man labour having at its command a certain amount of power provided mainly by horses and partly at the present time by motor tractors, internal combustion and steam engines. The cost of farm work per unit depends therefore on the efficiency of organisation of all the forms of farm labour, manual, horse, and machine equipment.

Over the period 1870-1928, nearly sixty years, the horse has been the principal medium of tractive power on farms. It has not however, been considered by the Welsh farmer solely as an aid to manual labour in the accomplishment of farm tasks. Horses have been regarded also as a productive department of livestock, although interest in this branch of production has tended to diminish since 1920, largely owing to the low levels of prices. Some of the counties of Wales have in the past been renowned for their heavy horses, a number of which were available for "export" each year. In other districts large numbers of animals were sold yearly for use underground in the coal producing areas, while other parts specialised in surplus production of Welsh cobs and ponies. It is probable therefore that at all times Welsh farmers have kept a certain proportion of horses surplus to the maximum requirements of farm tasks. In view of the fact that some of the horses would be put up ultimately for sale, it is possible that the farmer paid less attention to the amount of work done per horse and to the number of horse hours taken per unit to task. Work on the farm for some horses was, to a certain extent, regarded as exercise and training in preparation for sale. To-day, however, when prices realised for horses are comparatively low there is a greater realisation on the part of farmers that horse labour on the farm is an important item in cost and that organisation of horse labour should be critically examined with a view to greater output per unit of cost. Unfortunately, it is not possible to obtain a measure of the degree to which the Welsh farmer regarded his horses as units of tractive power only at different periods. But it can be safely said that it has always been the most important aspect and that the degree to which he has succeeded in paying for the cost of keeping horses by work done on the farm at different periods merits investigation.

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[1] Ashby and Davies: The Work Efficiency of Farm Organisation in Wales. This *Journal*, Vol. V, pp. 50-67.

The figures relating to horses presented throughout the study are taken from the Ministry of Agriculture *Statistics*, and in order to eliminate any abnormal variations in one year an average of three years has been taken in each case, *e.g.*, figures shown for 1871 consist of the average for 1870, 1871 and 1872.

Changes in the numbers of working horses and total horses on Welsh farms are illustrated in the following table.

TABLE I.

Number of horses in Wales and Monmouth, 1871–1927.

Period.	*Wales.*		*North Wales.*		*South Wales.*	
	Working horses.	*Total horses.*	*Working horses.*	*Total horses.*	*Working horses.*	*Total horses.*
1871	75 786	126 964	27,570	46,776	48,216	80,188
1881	78,924	148,417	29,379	53,963	49,545	94,454
1891	81.683	160,041	31.796	56,326	52,887	103,715
1901	99.238	167.297	36,739	59,505	62,494	107,792
1911	101,338	174,835	36,230	60.296	65,108	114.539
1921	91.624	178,056	31,818	61,531	59,806	116,525
1927	82,302	136,574	28,365	46,383	53,935	90,191

Attention will be directed mainly to the " working horses ", but it is interesting to note that the proportion which they form of the total horse group has remained fairly constant throughout the period. For Wales as a whole the numbers of working horses increased steadily until about 1911, whereas for the two later periods they show substantial reductions in number. At the present time the numbers on farms for the whole country are still slightly higher than at 1871. For North Wales, however, numbers in 1927 were actually less than in 1871, while for the South the 1927 figure was still substantially higher than for any period up to 1900. Reference will be made to this difference between North and South at a later stage.

A better picture of the change in the relation of horse labour available to other parts of the farm organisation such as man power and total area will be obtained from Table II.

TABLE II.

Number of working horses per 100 acres of land and per person.
North Wales; South Wales; Wales and Monmouth, 1871–1927.

Period.	*Per 100 acres cult. area.*			*Per person.*		
	North Wales.	*South Wales.*	*Wales & Mon.*	*North Wales.*	*South Wales.*	*Wales & Mon.*
1871	2.4	2.7	2.6	.55	.72	.65
1881	2.6	2.6	2.6	.61	.82	.74
1891	2.7	2.7	2.7	.72	.94	.84
1901	3.2	3.3	3.2	.88	1.20	1.06
1911	3.2	3.5	3.4	.85	1.20	1.04
1921	2.9	3.4	3.2	.79	1.16	1.00
1927	2.7	3.2	3.0	—	—	—

Little difference is to be found in the relation between working horses maintained and the area of land for North and South Wales separately, although the number of horses per 100 acres increased gradually from 1871. The comparison between North and South Wales is of greater interest when working horses are related to persons engaged. The tendency to associate an increasing amount of horse labour with the labour of each person is evident at each decade, and this tendency is apparent for both North and South Wales.

It was estimated that in 1871 the "task" per person in South Wales was some 8 per cent. greater than in North Wales, also that the increase in the task between 1871 and 1921 was greater in South than North. It thus appears that the accomplishment of a greater task in South Wales is definitely associated with more extensive use of horse labour with each unit of manual labour. As the increase in the task per man was made possible mainly, if not wholly, by changes, improvements and increases in mechanical equipment, it obviously required also the use of more power chiefly for tractive purposes. Such power was obtained mainly from horses. The workers in South Wales have had proportionately more horse labour associated with them than those of North Wales and the increase in horses per person has been a little greater in South than North, so that a definite connection between the use of horses and equipment, and the increase in task per person is to be seen.

A more detailed view of some of the changes can be obtained by relating the number of horses to the land and stock as is done in Table III.

TABLE III.

Task per working horse, 1871-1927.

Acres of land and numbers of livestock per working horse, Wales and Monmouth.

	1871	*1881*	*1891*	*1901*	*1911*	*1921*	*1927*
Total cultivated area	37.2	38.3	36.8	30.9	29.7	31.0	33.7
*Tillage area	10.5	8.7	7.0	5.2	4.7	5.6	4.5
Pasture	18.4	21.0	21.1	18.2	17.1	17.1	19.6
Hay	8.3	8.6	8.7	7.5	7.9	8.3	9.6
Total grass	26.7	29.6	29.8	25.7	25.0	25.4	29.2
Dairy cows	3.5	3.5	3.6	3.0	3.0	3.5	4.1
Other cattle	5.0	5.3	5.7	5.0	4.8	5.0	5.9
Total cattle	8.5	8.8	9.3	8.0	7.8	8.5	10.0
Sheep	38.9	34.1	40.0	37.0	38.0	37.0	50.1
Pigs	3.1	2.7	3.1	2.4	2.3	2.3	2.7

* *Tillage area* represents land actually under the plough, expressed in following Tables as percentage of cultivated area.

The number of acres of all land for which each horse on the average was responsible fell by 22 per cent. between 1881 (the highest point) and 1911, when it rose slightly. In 1927 the figure was 12 per cent. below that of 1881 and 10 per cent. below that of 1871. Tillage land per working horse in 1927 was less than half the 1871 figure and tillage represents the greater proportion of horse work on the farm. Acreages of pasture and hay show little change except for 1927, where the sharp decrease in number of horses followed the laying down of land to pasture and hay since 1921. Cattle and sheep increased in total numbers considerably in the period 1870-1927, but the effect is less apparent except with sheep when related to working horses which also increased during the period.

To obtain one comparable index of the task per working horse at the different decades the horse labour requirement in terms of horse hours have been applied to units of task. These time requirements are the actual averages obtained from a study of horse labour on a group of Welsh mixed farms for the years 1926 and 1927. The horse labour time requirements shown below have been utilised throughout.

Horse labour on poultry, and on general farm or establishment work which could not be charged to a specific task,

Task units.		*Horse hours.*
Tillage land	per acre	80.0
Pasture	do.	0.5
Hay	do.	11.0
Total horses	per head	1.0
Do. cattle	do.	0.9
Do. sheep	do.	0.2
Do. pigs	do.	1.5

accounted for about 10 per cent. of total horse time worked, and this is the figure utilised in this study.

If these requirements had existed in previous decades the total task per horse would have been very much greater at most periods than in the most recent years. As a matter of interest the calculation of the horse-task on the basis of acres of land and numbers of stock, at the unit requirements of 1925-27, may be shown for earlier periods. The data on which the actual number of hours required at the various periods could be estimated unfortunately does not exist.

TABLE IV.

Index of total task per working horse.
Wales and Monmouth, 1871-1927.

Period.	*Total hours per horse.*	*Total task index.*
1871	1,069.2	195.5
1881	913.1	167.0
1891	766.3	140.1
1901	586.1	107.2
1911	541.3	99.0
1921	631.4	131.9
1927	546.8	100.0

The estimated working time of each working horse in Wales as shown above for 1927 was seventy-eight days of seven hours. Had each acre of land, each unit of stock of 1871 required as much horse-time as to-day, the working-time per horse would have been about 134 days of eight hours.

However, as previously stated, changes in equipment and in organisation of power and labour have transferred work from men to horses. To take only two simple instances, the mowing machine and the reaper or self-binder transferred the cutting of hay and corn. Work on arable land and hay now account for about 85 per cent. of the total horse labour, and it is probable that the arable land always accounted for more than 60 per cent. of the time worked.

The greatest proportional diminution in manual labour requirements per unit comparing 1871 and 1921 were found for arable crops and hay, although for livestock, which account for a substantial part of man labour on the farm, gradual reductions of unit time were shown with advanced decades. How far have the reductions in man labour resulted in increase of horse hours per unit of work? This is the pertinent question. For horse labour however the principal task on the farm is, and has been, the cultivation and harvesting of cereal and root crops.

TABLE V.

Percentage distribution of horse labour time, 1921-1927. (With estimate for 1911).

	1911	*1921*	*1927*
Tillage ...	68.7	71.0	64.4
Pasture ...	1.6	1.4	1.8
Hay ...	16.1	14.5	19.4
Total land ...	86.4	86.9	85.6
Horses ...	0.3	0.3	0.3
Cattle ...	1.3	1.2	1.6
Sheep ...	1.4	1.1	1.8
Pigs ...	0.6	0.5	0.7
Total livestock ...	3.6	3.1	4.4
Total direct labour ...	90.0	90.0	90.0
Establishment labour ...	10.0	10.0	10.0
Grand total ...	100.0	100.0	100.0

Even with the large decrease in total arable and in the amount of tillage per horse it will be seen from the table that for 1927 work on tillage land accounts for 64.4 per cent of horse working time. The horse work per acre in cutting corn is certainly greater to-day than sixty years ago. But the increase in horse hours required with the introduction of self-binders is certainly much less than the decrease in manual hours. For the operations following actual cutting and binding such as stooking and cocking the man hours have decreased slightly, but they are tasks that do not affect horse labour. The horse labour required for carting and stacking of corn remain much the same, apart from the fact that as tillage land is diminished there is a tendency to cultivate fields nearest to the homestead. For ploughing and cultivating, and preparation of the seed bed there are several factors which have affected horse labour requirements. First, the improvement in type of plough, which has reduced draught and speeded up work. Better and more effective cultivators and harrows have been introduced, shortening the time required for these operations, and in general these improved implements go towards economy of horse labour time. Secondly, improved equipment and better technique of cultivation acquired by the farmer have enabled the number of operations necessary in the preparation of land for crops to be reduced. Again a small proportion of the work of ploughing and cultivating is done to-day by tractors. This more than balances the amount of steam plough work done on farms before 1900, as this means of tractive power was only used to a very limited extent in the counties on the Eastern border. It is probable that on a majority of Welsh farms the seed is drilled to-day whereas it was almost entirely broadcasted in the earlier decades, but this entails little saving of manual labour and an increase of horse labour. With threshing the horse labour requirements were certainly greater in the earlier decades, when the horse gear was used on many farms as compared with to-day, when there is less threshing to be done and more farm threshing machines are driven by engines.

The same remarks apply with regard to cultivation of all arable crops, cereals and roots. Horse work has been gradually increased, however, in the cleaning and hoeing of root crops, and the horse hoe is used oftener and is a more effective implement than in decades preceding 1900. With greater intensity of livestock feeding there has developed more carting of root crops to the homestead; this is especially true of mangels, which have increased greatly in acreage over the period.

In contrast to horse work on arable crops where horse labour requirements, although greater for such operations as cutting, are probably less in 1927 than they were in the earlier decades before 1900, horse work on hay and pasture has certainly increased. Increase of horse work with the use of the mowing machine in cutting hay has resulted in a great saving of man labour. The introduction of the horse rake, swathe turner, tedder, hay grab and to-day the hay loader and elevator on many farms has meant a gradual increase in horse labour, although not equivalent to the man hours it dispensed.

But the importance of the increase in horse work does not necessarily arise from the total amount per acre or per farm. It is the relationship between requirements and the period of time over which work can be spread which decides the number of horses that have to be maintained for farm work. This applies both to work on arable crops and hay, and it is likely to have been of greater moment with arable crops when there was a substantial acreage per horse as in the earlier decades than it is to-day. With the increase of the horse labour requirements of hay, the greater acreage of hay per horse, and the comparatively short period of time available for dealing with the crop, it is not unlikely that the requirements of this crop make the period of peak demand for horse labour to-day, and in this way go far in deciding the horse requirement per farm. The monthly distribution of horse labour on Welsh farms in recent years was as follows :—

	Per cent.		*Per cent.*
January ...	5.1	July ...	11.4
February ...	6.9	August ...	6.7
March ...	11.5	September ...	8.8
April ...	13.4	October ...	6.4
May ...	10.0	November ...	4.7
June ...	8.5	December ...	6.6

The task in the form of arable land per horse was being gradually reduced throughout the period except for the special war-time cultivation. The acreage of hay and pasture per horse increased from 1871 to 1881, then fell and remained low in the three following decades and rose again after 1921. But horse labour on pasture and hay, especially on hay, was certainly increasing. Horse work on pasture has tended to increase with improvement in manuring and technique of surface cultivation, but they are tasks which can be performed during slack periods and hardly affect intensity of demand. They rather take up slack time. A general reduction of total horse task does not mean that fewer horses are necessary if new peaks of demand for labour have been created.

Reference to Table V shows that horse work on land in 1927 accounted for about 85 per cent. and horse work with live stock for 4.4 per cent. of the total. Although greater intensity of stocking and feeding of stock which proceeded with advancing decades required more horse work, especially with lowland sheep, the total increase has not been such as to affect horse labour economy to any appreciable extent on mixed farms. With dairy farms, however, milk delivery and cartage of foods has absorbed a proportion of the horse labour available from the decrease of tillage.

In arriving at the total index of task (Table IV) establishment has been taken at 10 per cent., which was the figure obtained for 1926-27. The probability is, however, that more general work was done on farms in the earlier decades. Grinding of corn in the local mill accounted for many journeys during the winter and the introduction of the farm grinding mill has meant a saving of both man and horse time.

Farm vehicles, on the whole, would show considerable improvement over those commonly in use in the seventies and eighties, although in parts of Wales primitive vehicles are still to be seen on the farms and roads. Between 1900 and 1920 it is practically certain that there would be a general increase in cartage, especially of feedstuffs and fertilisers. The amount of driving for business and family purposes probably increased as the roads improved up to 1914, when the motor car began to appear in some districts. Since 1920 (and more particularly since 1924) motor buses have carried members of the family and motor lorries have delivered goods to the farm. Both these changes are still proceeding.

Following the differences in manual labour task found for North and South Wales, the task per working horse has been analysed for both areas (Tables VI and VII). The total area of North Wales is about 2,050,000 acres, and that of South Wales about 3,050,000 acres, while the numbers of work horses in 1927 were 28,365 for North Wales and 53,935 for South Wales. With manual labour the task accomplished per person was found to be consistently greater and the efficiency per hour higher for the South than for the North. The respective figures for work efficiency per man being for 1921 in the ratio of 100 : 114 for North and South Wales.

The number of work horses maintained per 100 acres of cultivated land has tended to be higher in South as compared with North Wales, especially in the later decades (Table II). The total task per working horse for each decade, as can be seen from Tables VI and VII, has been consistently higher for most items, especially for tillage and hay land which account for the greater part of horse time, for North Wales than for the South. For comparison of tasks in the two areas for three periods an index of total task on unit time requirements has been prepared (Table VIII).

Whereas South Wales shows a greater accomplishment in task for man labour, North Wales has shown a total task per working horse which has been consistently higher.

To proceed a stage further and show the influence of differences of farm organisation in their effect on economy of horse labour, calculations of task per working horse have been made

TABLE VI.

Land and Stock per working horse, North Wales, 1871–1927.

Acres of land and numbers of livestock.

Period.	*Tillage.*	*Pasture.*	*Hay.*	*Total cult. area.*	*Total horses.*	*Dairy cows.*	*Other cattle.*	*Total cattle.*	*Sheep.*	*Pigs.*
1871	11.7	17.2	9.5	42.0	1.7	3.9	5.7	9.6	46.2	4.0
1881	9.3	20.1	9.3	38.7	1.8	3.7	5.9	9.6	43.0	3.4
1891	7.7	20.0	9.3	37.0	1.8	3.9	6.3	10.2	47.8	3.9
1901	5.8	17.7	8.0	31.4	1.7	3.2	5.8	9.0	44.2	2.9
1911	5.4	17.4	8.5	31.3	1.7	3.3	5.9	9.2	49.1	2.8
1921	6.4	18.6	9.4	34.4	1.9	4.1	6.5	10.6	50.0	2.8
1927	5.1	21.7	10.7	37.6	1.6	4.8	7.5	12.3	70.8	3.3

TABLE VII.

Land and Stock per working horse, South Wales, 1871–1927.

Acres of land and numbers of livestock.

Period.	*Tillage.*	*Pasture.*	*Hay.*	*Total cult. area.*	*Total horses.*	*Dairy cows.*	*Other cattle.*	*Total cattle.*	*Sheep.*	*Pigs.*
1871	9.8	19.2	7.6	36.7	1.8	3.3	4.5	7.8	34.7	2.6
1881	8.4	21.5	8.2	38.1	1.9	3.4	4.9	8.3	28.9	2.3
1891	6.6	21.7	8.4	36.6	2.0	3.5	5.1	8.6	35.2	2.2
1901	4.9	18.4	7.2	30.5	1.7	2.9	4.5	7.4	32.4	2.1
1911	4.2	17.0	7.5	28.8	1.7	2.8	4.3	7.1	31.8	2.1
1921	5.2	16.3	7.7	29.2	1.9	3.2	4.2	7.4	30.0	2.0
1927	4.1	18.6	9.0	31.7	1.7	3.7	5.0	8.7	39.2	2.4

TABLE VIII.

Index of total task per working horse, North Wales and South Wales, 1911, 1921, and 1927.

Period.	*Total hours.*		*Index of task.*		*Index of task S. Wales = 100.*	
	South Wales.	*North Wales.*	*South Wales.*	*North Wales.*	*South Wales.*	*North Wales.*
1911	494.0	620.2	98.1	98.2	100	125.5
1921	585.0	722.5	116.2	114.4	100	123.5
1927	503.5	631.5	100.0	100.0	100	125.4

for each county in Wales for 1927. The problem of utilisation of horse power cannot be solved along the same lines for each farming system. In some of the dairying areas, the whole economy of the farm is different from those where mixed farming is practised, and the utilisation of horse labour is mainly a problem of relating a high hay acreage and a large amount of general cartage to the available horse time. On mixed farms with a fair proportion of tillage the peak of demand for horse labour may still be in March or April. In so far, however, as relative horse economy for different areas is indicated by total task per horse (omitting variations in the seasonal distribution of the task) the table below, where the indices are arranged in increasing order, illustrates the position for 1927.

TABLE IX.

Index of total task per working horse for each county in Wales, 1927.

County.	*Total work hours.*	*Index of task. Wales = 100.*	*Per cent. tillage.*	*Dairy cows per 100 acres.*
Monmouth ...	400.3	73.2	8.6	10.1
Carmarthen ...	407.9	74.6	9.2	14.1
Glamorgan ...	429.7	78.6	10.8	13.0
Brecon ...	483.9	88.5	10.3	9.5
Radnor ...	563.1	103.0	12.3	7.5
Flint ...	583.2	106.5	12.6	19.6
Montgomery ...	585.0	107.0	13.6	10.4
Caernarvon ...	600.1	109.8	11.8	15.1
Pembroke ...	612.3	112.0	16.4	12.8
Anglesey ...	640.2	117.1	14.6	11.5
Merioneth ...	676.2	123.7	10.1	10.1
Denbigh ...	691.9	126.5	16.0	12.5
Cardigan ...	717.8	131.3	21.7	11.1
Wales and Monmouth ...	546.8	100.0	13.0	12.2

Topographical, climatic and soil conditions influence to some extent utilisation of available time, but the main factors causing variations are included in differences of farm organisation, represented in the main by the proportion of tillage land as shown in the table. The correlation between total task and proportion of tillage to total area is very high.

In addition, some districts show better utilisation of man labour and have increased its capacity by better utilisation of horse work and provision of more and better equipment. Other areas have increased stocking of farms while decreasing the amount of tillage, thus increasing the task accomplishment of persons engaged, but making a great decrease in task per working horse.

Considering the relative task of the working horse on Welsh farms at different periods it appears certain that it has decreased substantially since 1871. Numbers of working horses on farms are greater to-day than in 1871, although there has been added to the power equipment of farms a number of tractors and engines each either displacing or supplementing horse work.

It is worth noting in this connection that with the decrease in tillage the task of each implement tends to decline, and capitalisation with depreciation on capital tend to increase in relation to work done. The same general equipment for arable cultivation is often found on farms of similar soil whether 25 or 35 acres are under the plough, and in the process of decreasing arable there comes a time when it may be better to sacrifice the whole rather than maintain equipment for a small area. On the other hand, the task of hay harvesting machinery tends to increase.

It is not intended to say, however, that Welsh farmers to-day are less painstaking in attempting to get the maximum of productive hours of work for each horse maintained. With the changed circumstances of farming the total task is small measured over the whole year, but large enough possibly to employ all available horse time at peak periods. Maintenance of horses is a heavy cost for all farmers and it might be well for Welsh farmers to reconsider farming systems with a view, amongst others, to utilising their horse labour productively for a greater proportion of the year.

The dominant factors in the situation appear to be the March-April and the July peak demands. Farmers may reduce the work in March and April on the preparation for planting of the cereal crops, and in May in the preparation for roots, but while reducing tillage and doing this they increase the acreage of hay and increase the July demand for horse labour.

A REVIEW OF AGRICULTURAL CO-OPERATION IN WALES.

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The present is an opportune moment for reviewing the agricultural co-operative movement in Wales. The twenty-five years or so of experience behind the movement have many points of interest, both theoretical and practical. And to-day, at a time when co-operation is more than ever on its trial, it would be well to examine the present scope and problems of the movement. An impartial survey might benefit two schools of thought on co-operation in agriculture—that which regards it as a panacea for all farming problems, and that which adopts an attitude of suspicion and scepticism and what may be worse—of apathy.

It must be admitted that within the last three decades co-operation in Welsh agriculture, taken as a whole, has proved its worth. Sufficient time has elapsed to test the validity of the co-operative principle of organisation, and societies collectively have stood up to the test. Judged by the imperfect measuring rod of statistics, the progress of co-operation has been very marked, although its failures have been numerous and significant. The progress of the movement since 1902, prior to which only one society had been registered, is shown in the accompanying table.

It will be seen from the table that societies organised for the joint purchase of goods required in production have always been the backbone of the Welsh movement. These businesses now cover the greater part of the Principality and supply Welsh farmers with at least one third of their total requisites. In building up this position, the leaders of the movement had to combat great difficulties—such as the force of vested interests, together with much passive and some active resistance from farmers. And when farmers did join the movement they had not sufficient faith in it to give it the necessary financial backing. It is estimated that the financing of the average member's trade for a year requires a capital sum of £16; but the average contribution in paid-up share capital per member is only £4. Despite this handicap, societies by careful conservation of profits have built up such a financial position that in sixty-two out of the sixty-four requisite societies each £1 contributed by members was worth £2 14s. 9d. in 1928. Accumulated profits literally saved to the industry are being used to finance the purchase of farm requisites. In this connection the margins on which the average society works

Agricultural co-operation in Wales and Monmouthshire, 1902–1928.

Year.	*Requisite Societies.* No.	Members.	Share Capital.	Sales.	*Produce Societies.* No.	Members.	Share Capital.	Sales.	*Miscellaneous.* No.	Members.	Share Capital.	*All Societies.** No.	Members.	Share Capital.	Sales.†
			£	£			£	£			£			£	£
1902	6	266	950	2,557								6	266	950	2,557
1903	15	1,768	1,749	17,067								15	1,768	1,749	17,067
1904	20	2,165	2,556	33,887								20	2,165	2,556	33,887
1905	22	2,486	2,972	41,253					2	82	380	24	2,568	3,352	41,253
1906	31	3,148	3,558	68,714					3	95	390	34	3,243	3,948	68,714
1907	31	3,613	3,113	97,080					1	8	155	32	3,621	3,268	97,080
1908	36	4,065	3,616	119,116					1	8	157	37	4,073	3,773	119,116
1909	44	4,893	4,428	151,322					1	8	157	45	4,901	4,585	151,322
1910	46	5,308	5,487	178,404	1	18	17	8	1	8	157	48	5,334	5,661	178,412
1911	52	6,104	6,633	222,477	3	126	228	693	2	8	1,468	57	6,238	8,329	223,160
1912	53	7,105	8,126	288,738	4	200	282	3,981	2	80	3,000	59	7,385	11,408	292,719
1913	61	8,036	9,773	330,567	6	465	1,268	10,391	2	77	3,230	69	8,578	14,271	340,958
1914	69	9,260	11,123	407,504	5	459	1,530	11,889	2	77	2,830	76	9,796	15,483	419,393
1915	73	11,316	13,235	560,740	5	512	1,409	17,225	2	79	3,012	80	11,907	17,656	577,965
1916	81	13,012	15,396	766,537	5	486	1,561	21,145	2	80	3,014	88	13,578	19,971	787,682
1917	83	15,520	21,642	868,685	7	805	1,761	34,634	4	95	4,358	94	16,420	27,761	903,319
1918	86	17,917	28,616	906,015	10	1,270	4,693	88,548	9	422	7,283	105	19,609	40,592	994,563
1919	84	20,122	45,885	1,219,498	18	2,006	12,940	263,390	12	510	8,808	114	22,638	67,633	1,482,888
1920	83	21,391	70,426	1,822,580	25	2,729	21,205	331,492	13	592	10,716	121	24,712	102,347	2,134,072
1921	82	22,373	135,942	1,645,308	26	2,917	23,620	216,232	15	904	10,005	123	26,194	169,567	1,861,540
1922	80	22,350	143,598	1,277,826	27	2,971	24,241	212,163	13	925	7,897	120	26,246	175,736	1,489,989
1923	81	22,437	148,743	1,258,777	27	2,078	19,820	217,396	13	954	6,006	121	25,469	174,569	1,476,163
1924	81	22,522	140,915	1,369,750	24	2,038	19,459	164,710	13	959	7,079	118	25,519	167,453	1,534,460
1925	78	22,617	146,316	1,379,485	20	1,753	18,632	111,856	11	925	7,756	109	25,295	172,704	1,491,341
1926	75	23,310	139,240	1,215,784	12	1,511	7,623	26,249	10	670	5,564	96	25,671	152,427	1,242,033
1927	70	22,967	140,858	1,271,859	13	1,455	7,798	22,617	10	587	5,574	93	25,009	154,230	1,294,476
1928	64	22,362	137,404	1,350,129	11	1,025	6,345	24,615	10	634	5,622	85	24,021	149,371	1,374,744

* Excluding Allotment and Smallholding Societies. † Excluding receipts of Miscellaneous Societies.

might be stated. For each £1 worth of goods sold, 18s. 6d. represents the cost of the goods, and of a gross profit of 1s. 6d. per £, only 4d. remains as net profit of the business. No one could deny that the curtailment of distribution margins to these dimensions is an achievement in which requisite societies can justly take pride. Moreover, there can be little doubt but that requisite societies have introduced a high standard of business integrity into the farm supplies trade.

Although there have been failures among requisite societies —and no movement or form of organisation can claim 100 per cent. success—their successes have been in marked contrast to the failures of many produce societies. The causes of most failures have been discussed elsewhere and only one or two things need be said at this juncture.[1] The majority of failures can be ascribed to economic conditions over which the leaders of societies had but little control. The decline of the dairy societies, for example, can be explained in that way. Very few examples of well thought out marketing schemes, operating in favourable circumstances can be found in the history of Welsh co-operation, and in fairness to the movement as a whole it must be remembered that the financial loss suffered by farmers on account of failures of marketing societies represents only a fraction of the benefits derived from the successful trading of purchase and other ventures. The broader issues of co-operative marketing will be discussed at a later stage.

Features of the present position.

A quantitative measure of the present position is offered in the table on page 58 and the accompanying map.

The first broad generalisation indicated in the above table is that most societies in the Principality are small, and that areas differ greatly in this respect. Half the requisite societies are businesses of £10,000 sales or less per annum, while none of the existing produce marketing societies pass this figure. This characteristic of the Welsh movement can be largely attributed to the topographical features of the country and to the type of people who lead the societies. It is significant that the few large requisite businesses which do exist are situated in the more low-lying parts of the Principality. In the more hilly counties the knitting up of large areas under one business was a real difficulty especially before motor transport, necessitating better roads, opened up the countryside. Very few societies have been formed since motors

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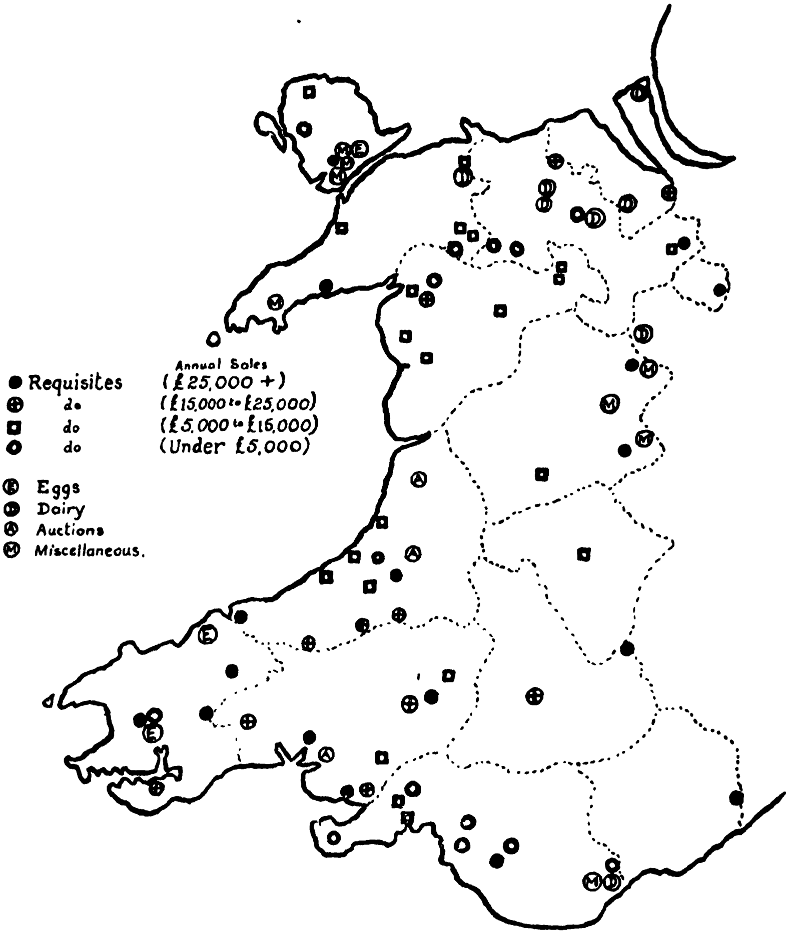
[1] Agricultural Co-operation in North Wales. Jones and Wynne, Agricultural Economics Department, U.C.W., 1928.

Distribution of Co-operative Societies, 1928.



Six other societies are on the register, but being dormant, they are not included.

have been the chief vehicles of rural transport. It might be argued that the sheer limits set by the topographical face of the country to large scale businesses was actually a factor in fostering the requisite movement in its early stages. In small communities it is not unlikely that farmers would wish to challenge local monopolies; the community feeling would be strong, and a certain pride would be attached to the formation of a co-operative society. Parochialism, caution, and conservatism have hitherto been friends of co-operation in Wales; but different points of view must be adopted if the movement is to flourish in the future.

But what makes the Welsh movement really unique is its lack of symmetry; in other words, the virtual monopoly by the

Business statistics, 1928.

County.	*No. of societies.*	*Member-ship.*	*Sales of requisites.*	*Sales of farm produce.*	*Total.*
			£	£	£
Anglesey ...	4	954	53,088		53,088
Brecon ...	1	440	21,006		21,006
Caernarvon ...	5	1,452	77,814	10,000	87,814
Carmarthen ...	10	6,998	454,614	28,423	483,037
Cardigan ...	9	3,743	136,823	3,684	140,507
Denbigh ...	5	1,293	104,508		104,508
Flint ...	4	1,137	70,651	31,328	101,979
Glamorgan ...	9	1.562	68,856	1,660	70,516
Merioneth ...	9	1,926	82,232		82,232
Monmouth ...	1	269	55.423		55,423
Montgomery	2	704	50,338		50,338
Pembroke ...	4	1,768	93,360	200	93,560
Radnor ...	1	116	6,121		6,121
Total requisites	64	22,362	1,274,834	75,295	1.350,129
Dairy societies	8	279		16,978	16,978
Egg societies	3	746		7,637	7,637
Auction mart	3	361			126*
Miscellaneous	7	273			2,622*
Grand total ...	85	24,021	1,274,834	99.910	1,377,492

* Represents *income* only. The value of stock sold in the auction marts cannot be stated.

requisite societies of the movement's business. Well may it be asked why the joint sale of produce is such a stunted plant while the collective purchase of requisites shows much vitality. Does the difference imply a limitation to the applicability of the co-operative principle in agriculture? If the facts are carefully examined, such a conclusion hardly seems permissible.

The requisite movement began to develop at a time when farmers in the Principality were becoming increasingly dependent on purchased manures and feeding stuffs. This silent change in farming method gave co-operation its chance: farmers felt the common need for an organisation which would give them the best terms and service in the purchase of their requisites. A few early successes gradually paved the way for the expansion which became general after 1910 and was accelerated by war conditions. The essential point is that the requisite societies fitted in admirably with the scheme of agricultural production, and that farmers were conscious of the position. But though these were the bases of success, other factors have contributed largely to the success of joint purchase societies. Under modern conditions of manufacture farm requisites are standardised goods, the prices and qualities of which are easily comparable and for the sale of which there is an elaborate machinery in operation. Buying such goods for resale is not an extremely difficult matter, especially now that price reporting is so thorough. And furthermore the market for farm supplies is round and about the society and the salesman of the society is usually in close contact with his customers. In brief, the distribution of farm requisites is a relatively easy and cheap process because of the nature of the goods handled.

While the above mentioned conditions explain the growth of the requisite societies, the absence of such conditions largely account for the checkered career and limited scope of produce marketing societies. Until about 1922, or even later, little dissatisfaction was expressed with the existing marketing machinery and although isolated efforts to break its armoury had previously been made, these efforts did not arise from a widespread desire for better marketing systems. In other words, there was little consciousness of a common need for new institutions.

But perhaps the greatest difficulties arose—as they still do—out of the essential differences between farm and industrial products as commercial commodities. To connect producers and consumers of farm produce, to adapt the supply of the former to the latters' demand in point of quantity and quality are complex processes. The produce must be assembled from scattered farms, must be manufactured, processed or submitted to some grading or standardising process, and must be sold, for the most part, in distant markets. The buyer's task is complicated by wide variation in quantity and quality and the lack of reliable market intelligence.

The main problem in selling farm produce is to set up good trade connections with distant purchasers and to find outlets for produce in glut seasons. The difficulties are rendered more acute by the constant fluctuations in the prices of farm products, involving in turn a great element of risk. Unlike requisites, few farm products can be bought and sold on contract. From a purely co-operative standpoint two further difficulties presented themselves; the need of considerable capital, and secondly, the relentless, if temporary, competition of existing middlemen. This latter has been and still is a strong deterrent to the expansion of joint sale. Any development means the displacement, in part at least, of time-honoured institutions, and the sacrifice of some of those personal relationships which always count for so much in rural Wales. All things considered, therefore, it is not surprising that the co-operative movement in Wales has largely confined itself to the purchase of requisites. In doing so it has acted logically and wisely in that the easier task has been tackled first.

Present-day problems.

The joint purchase of requirements.

It would be unfortunate if the foregoing remarks create the impression that all is well with the requisite societies, that they have solved all their problems. Such, of course, is not the case, and much needs be done to introduce a higher level of efficiency throughout the movement. There is also ample scope for further expansion. The widely varying degrees of efficiency amongst requisite societies is illustrated by the following facts: some societies own 95 per cent. of the capital used, while some others have to borrow 80 per cent. of it; several allow six months credit, while a minority clear their books in three weeks; in one case, costs of service amounted to 17 per cent. of the sales, in one other to only 2.4 per cent.; and financial results varied between a profit of 10 per cent. and a loss of 8 per cent. on sales of 1928. In fact, there are few societies which could not improve their results by giving more attention to buying, internal organisation, price fixing and salesmanship and taking steps to improve the credit position. Much could be achieved if only each society examined its own accounts and organisation critically and intelligently.

But viewing the future course of development of requisite societies the most general problem is that of increasing the size of the average business. The following table will indicate to what extent this is necessary and desirable.

Business Statistics by Size Groups, 1928.

Size group. Sales per annum.	*No. of societies.*	*Average sales.*	*Per £1,000 sales.*		
			Gross profits.	*Service costs and discounts on sales.*	*Net trading profit or loss.*
		£	£	£	£
£5,000 or less	13	3,633	65.8	74.3	— 8.5 *
£5—£15,000	21	8,793	76.25	54.9	21.35
£15—£25,000	11	20,946	74.05	68.3	5.75
£25,000 or more	17	53,393	79.7	61.5	18.2
Averages ...	62	22,094	77.8	62.1	15.7

* Loss.

Some of the factors accounting for the size of societies have already been discussed. The problem of the moment is to reduce the economic handicap associated with very small business units. The task confronting the very small society is one of buying goods at a sufficiently low price to enable them to be distributed at competitive prices after bearing high handling costs per unit. The small business must be very efficiently managed if, when prices, quality of goods and service are considered, it is to compete with the larger. But many of the small societies in Wales are not managed by people who make this possible; in fact the necessity of attracting efficient men by offering adequate remuneration has never been realised. Too many managers of small societies are untrained in the arts of buying. The possibility of raising the bargaining capacity of small societies by means of joint purchase by groups of societies is quite sound theoretically, and some successful efforts are now being made in this direction. But it is feared that for a while the disaster of the A.W.S. has killed the chances of any general resuscitation of this idea.

In the preceding table the trend of costs from one size group to another does not follow its expected course. Size Group III (£15—£25,000) contains two societies that are just emerging from serious difficulties. This and the next groups have a large proportion of societies which deliver goods, and this fact largely explains the higher costs. But there is little doubt but that the larger societies are the better equipped to meet the type of service now demanded. Selling farm requirements to-day is not merely a matter of price and quality of goods. " Salesmanship " is the key-note of modern commerce, and distribution is becoming more and more a question of providing service. In the farm supplies trade, more service implies more delivery to the farm. And more delivery in turn necessitates more canvasing and efforts to maintain close contact between a society and its customers. All these changes point to the need for larger societies, with reserves of capital for development. In fact there is every indication that the smaller societies are being hard pressed. The following comparison is illuminating.

Requisite Societies 1923 and 1928.

	Number.	*Average sales.*	*Sales of all Welsh societies.*
1923	81	£15,300	£1,258,777
1928	64	£21,100	£1,350,129

It cannot be denied that the disappearance of seventeen societies since 1923 is a loss to the movement, just in the same way as a retreat demoralises any army. But the disappearance of these societies when reviewed with other facts is more ominous than discouraging. To-day sixty-four societies are doing more business than eighty-one in 1923: the loss therefore has been in small societies. If to this is added the observation that no new requisite society has been started since 1924 and very few new branches have since been opened by existing societies, the trend of events will be appreciated. The small society is being gradually pushed out, and existing societies are expanding their trade by working their areas more intensively, chiefly with the aid of motor vehicles.

At the moment, half the societies in the Principality are not in a position to operate motor lorries economically. Unless they can be hired—and there are limits to the suitability of this practice—then these societies will be compelled to expand their businesses. In some areas at least, this raises the question of amalgamation. There is at least one area where three societies, each with sales of less than £10,000 per annum, are operating within a circle of ten miles diameter. There are some larger societies which compete with each other, and many instances could be cited in favour of the argument that the trading areas of societies could be redistributed on a rational plan. It is realised that local patriotism and personal considerations enter very largely into this calculation, but co-operators should now begin to consider the progress of the movement as a whole.

This discussion of the present position of requisite societies would not be complete without reference to the credit problem. The agricultural depression has not materially affected the volume of business done by the societies, but it has made profitable trading more difficult. Long credits affect costs, and therefore prices and profits. In 1928 the direct and indirect costs of credit to sixty-two societies were £3 13s. per £1,000 of sales compared with £2 1s. 6d. in 1927. It is open to question whether agriculturists generally, or in fact all those responsible for co-operative businesses, realise the handicaps which long credits impose on a business.[2] It is certainly true that some managers and committeemen have not appreciated the measure of control given them by the prompt presentation and repetition of accounts, the judicious use of cash discounts and price discrimination. In the following Table societies are grouped according to whether the costs of capital borrowed were greater or less than returns on capital invested and discounts given for prompt payment. This difference is a measure of the cost of credit and indicates the ramifications of delayed settlement of accounts.

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[2] Control of Credit. Ashby and Jones, Agricultural Economics Department.

Grouping according to net costs of financing trade.
Per £1,000 of sales.

	Net cost of more than £5.	*Net cost of less than £5.*	*Net surplus.*
	£ s. d.	£ s. d.	£ s. d.
Net cost of financing trade	9 2 6	2 5 10	2 16 8*
Management costs	78 5 10	48 16 8	48 8 9
Final profit or loss	— 4 12 1	17 1 5	27 3 4
Debtors ...	229 0 0	156 0 0	139 0 0
Per cent. of capital borrowed	72	38	22

* Investment income and discounts on purchases exceeding financial charges.

It is seen that from all standpoints the burden of long credits affects the trading position of societies. In the case of societies which have to borrow heavily, the handicap is very serious, since interest on borrowed capital must be paid whether or not the concern is working profitably. In stronger societies, freezing up reserves in trade credit is robbing the business of much needed funds for development, such as the improvement of premises and the purchase of motor vehicles. Where societies are just on the balance or faced with deficits, let it be hoped that a speedy return to agricultural prosperity will soon relieve their positions.

The co-operative marketing of farm products.

The statistical Table and map (pp. 57-58) show the present distribution and scope of societies organising the sale of farm products in the Principality. Three of the eight dairy societies are selling liquid milk. Two of these are engaged in the retail trade, while the third is doing a semi-retail business. The other five are the remnants of a group of about twenty-six societies which are mainly engaged in the conversion into cheese of surplus summer milk. The egg societies engage in the usual country business, while the three auction mart societies make local arrangements for the sale of livestock.

The average annual sales per society in the dairy and egg groups are only £2,288, and this fact largely accounts for their problems. They find it extremely difficult to trade profitably with the high unit costs incurred. Some are handicapped by lack of capital. In others, part time employment only can be offered, with the result that the management is not of a high standard.

The egg societies in particular suffer from lack of contact with good outlets for produce. Almost all the societies are handicapped by spasmodic supplies from members. None of these societies are attempting to do anything very ambitious, but it must be admitted that, as a whole, they do not perform their purely local functions with conspicuous success. With the majority of them a radical change of outlook on the part of members and of business methods on the part of the management are urgently called for.

In addition to the trade handled by produce societies as such, the activities of requisite societies in the sale of farm products must be mentioned. Unfortunately accurate statistics of this trade cannot be given, since some societies handle members' produce without showing it separately in their accounts. One society acts as agent to a wholesaler for the sale of members' milk, this trade being valued at £31,000 per annum. Several are known to sell potatoes and cereals on behalf of members, although only two societies record such trade, valued at £1,860. Six societies record sales of members' butter and poultry products totalling £48,000; one society accounted for £28,000 of this amount.

The requisite societies have not infrequently been criticised for their apathy towards the purchase of goods from members or the sale of produce on their behalf. Previous suggestions in this article almost invite the conclusion that for the past their conservatism in this respect may have been justified. The leaders of requisite societies probably felt that building up and expanding their businesses was a full-time task. They probably realised that the technicalities of handling farm products were essentially different from those involved in the distribution of farm supplies. And even if the establishment of a produce department were decided upon, the area covered by most requisite societies was so small that little trade in individual products could be expected. In other words, a radius of five miles may form an economic unit for a requisite society, but there are many districts where, under a diversified farming system, the volume of trade in individual farm products from such an area would be too small for economic working. It must be repeated, moreover, that the farmers' urge for market reform is a comparatively new one. When in earlier years some farmers and others were anxious to organise co-operative marketing of produce, great numbers of producers were apathetic.

Before considering further the relations of produce and requisite societies to the general question of marketing, it might be well to realise that from an organisation point of view, the products of Welsh farms fall into two broad categories. In the first group fall products such as butter, eggs and poultry and cereals, the marketing of which can be undertaken by local units. In connection with these products, many useful services can be performed by relatively small groups of producers, although, of course, their action must harmonise with regional and national conditions. To the second group belong those commodities for which the marketing unit must cover much wider areas, if efficiency is to be secured. In this category fall milk, store and fat stock and wool.

This important distinction might be illustrated with reference to milk, a commodity which may fall into both categories. Purely local action has often proved effective where producer-retailers have pooled their rounds and entrusted the distribution of their milk to co-operative societies, or in cases where surplus summer milk is converted. But the problems of liquid milk producers in the South-West Wales milk area, for example, could never be solved by such local action. If permanent success is to be obtained, co-operation in that area must take the form of regional action, where the supplies and returns of two or three counties are pooled.[3] Something similar is true of livestock selling. The three existing auction marts are doing something to ease the problem in their own small areas, but the isolated action of one village would do little to facilitate the flow of store stock to feeding areas or of fat stock to consuming centres. Had we in this country large centralised stockyards, such as in Chicago, local action in the form of livestock shipping associations would probably develop because they would serve a useful purpose.

These remarks are not intended as a criticism of local action : they are intended as guidance to schemes of joint action in the future. They show that as regards some products and services there is ample scope for the development of produce societies similar in type to those found in Wales at the moment. In fact, new developments in the marketing sphere make the expansion of such societies all the more likely and desirable. Better marketing is the topic of the day : there is growing among farmers a conscious desire for more efficient machinery. Farmers are realising that they must act collectively if they are not to be impoverished by highly organised groups in the distributive trade. The work of organisation is being facilitated by legislation, as evidenced in the National Mark Schemes associated with the Agricultural Produce (Grading and Marking) Act. Two societies have already taken advantage of the scheme as regards eggs.

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[3] Report of Three Counties Marketing Committee.

The Clynderwen Society is the model egg packing station for South Wales.

It is not unreasonable to expect the requisite societies to develop trade in the " local organisation " commodities mentioned above. In favour of this departure it can be argued that the requisite societies already possess a trading machinery which could be adopted to handling some kinds of farm produce. They have behind them a store of invaluable experience in dealing with farmers. Even from the point of view of the farm supplies trade, the wider buying of butter, eggs and poultry would be beneficial. Now that delivery of requisites to farms is becoming general, the economy of having lorries returning laden with products would seem obvious. It is not unlikely that the grocery branch of the trade could be expanded since in parts of Wales at least, butter and eggs are often bartered for household requisites. With a general expansion of farm produce trade by these societies some form of federation for certain purposes would prove helpful.

As regards marketing the " large scale " products which are such important items in the income of Welsh farmers, the failures of the past need not deter action for the future. Rather let the lessons of the past be learnt so that history will not repeat itself. If wool and livestock are going to be effectively marketed cooperatively, the new organisations must be entirely different from those previously set up in Wales. But the designers of such organisations will have much to assist them. They can draw on an ever increasing store of experience won by large scale and pooling organisations handling farm products all over the world. For example, such problems as how to finance big businesses from farmers' capital and how to maintain adequate supplies of goods have been solved in other countries. All over the world farmers are showing that large scale co-operatives can attain a high standard of business efficiency.

Conclusions.

The sceptical might be disposed to argue that far too ambitious a programme has been drawn up for the co-operative movement in Wales. If this view is based on a concept of the limitations of the co-operative principle, then it is a false one. Co-operation in Wales is and has been characterised by great versatility. The seven societies classes as " miscellaneous " are an interesting group. Three own and hire out threshing machines; two supply their villages with electric light. Of the remainder, one does useful work in sub-letting land to selected tenants, while the other sells thatching and horticultural mats on behalf of craftsmen in Anglesey. This list certainly does not indicate limits to the points at which co-operation can serve agriculture and rural life. If the movement will supplement its elasticity with vitality and courage, then it can grapple with many of the farmer's business problems. And after all, is co-operation possible without co-operators? Co-operation may be the child of necessity, but it is not merely a business machine. Its results cannot be dissociated from the human qualities of those who control its destines.

THE PRODUCTION AND MARKETING OF PIGS IN NORTH WALES AND CARDIGAN.

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I. Production.

In an area such as North Wales, where agricultural holdings are comparatively small, it would be expected that pig production in one form or another would occupy an important position in the farming of the area. Such, however, is not the case. For several reasons, such as the prevalence of rough grazing, low crop acreages, relatively high cost of concentrates, and the lack of an important consuming market, pigs occupy a relatively unimportant place in the farming economy. In butter producing areas the calf exercises the primary demand for the dairy by-products, whilst in the liquid milk areas surrounding local towns the adjustment between the production of and demand for milk is fairly efficient. In other areas where liquid milk is produced intensively for " export ", the pig plays an important part in the utilisation of surpluses. In small localised cheese producing areas, bacon production forms a subsidiary industry of some importance.

In parts of Wales where there are numerous cottage holdings of more than one acre carrying livestock which would be returned in the Agricultural Statistics, the decline in cottagers' pigs is of some importance. Cottage pig-keepers may be divided into two groups—those who have no land or less than one acre, and those who have one acre and upwards. The changes as regards pigs in the first group would not affect any records of the industry, but changes in the second group are reflected in the annual Statistics. Throughout both groups there has been a decline in pig-keeping. In the first group the chief causes are the greater stringency of modern sanitary regulations and the decline in home-curing of bacon. But the latter cause is also common to other cottage holdings, to the small and the larger farms. The cottage holdings are sometimes affected by sanitary regulations, but not to the same extent as the cottages without adjacent land.

The density of the pig population in the counties under consideration was as follows in 1925 and 1928, but in all counties except Caernarvon there has been an increase in density since 1925.

TABLE I.

Pigs per 1,000 acres cultivated land, 1925 and 1928.

	Sows.		*Other pigs.*		*Total.*	
	1925	*1928*	*1925*	*1928*	*1925*	*1928*
Anglesey ...	10	13	56	77	66	90
Caernarvon ...	7	8	53	66	60	74
Merioneth ...	5	6	34	47	39	53
Denbigh ...	13	15	87	99	100	114
Flint ...	16	21	127	148	143	169
Cardigan ...	10	12	63	76	73	88
England and Wales ...	12	15	91	102	103	117
Wales ...	10	13	63	76	73	89

Changes in the pig population 1865-1928.

From 1865 to 1891 the trends of pig population in the six counties were steadily upward. In Flint alone the trend continued upward for another seventeen years until 1908. From 1892 (1908 in Flint) a decline set in which varied in extent in the different counties and which continued until about 1919. In five of the six counties the trend since 1919 has been steadily upward, but in Caernarvon the fall continues. Based on the trend the following changes in pig population have taken place between 1891 and 1928 :—

Caernarvon	Decrease	56 per cent.
Anglesey	,,	35 per cent.
Merioneth	,,	32 per cent.
Cardigan	,,	14 per cent.
Denbigh	,,	4 per cent.
Flint	Increase	6 per cent.

The chief causes of these differences between counties appear to be :—

1. The greater development of dairying, especially cheese-making, in Denbigh and Flint makes dairy by-products available for pig-feeding. In Flint and parts of Denbigh few calves are reared, and there is little competition between calves and pigs for skim-milk and whey.
2. Some counties have changed over from bacon to pork production more rapidly than others. The adaptation of, or the failure to adapt, production to market requirements has a strong influence on production. Where pigs are important, adaptations are apt to be considered and made more quickly than where numbers are small and receipts relatively unimportant, and this appears to have been the case in North Wales.

   There has been a price margin in favour of porkers and cutters for some years. It is also possible that under some circumstances pork may be produced at lower costs than bacon. But to a certain extent the production of one type of product or another is dependent on the connection between pigs and other farm enterprises and on the organisation for marketing products.
3. Dependence on purchased foods for pig-feeding has been increasing for a long period. Pig-keepers in Anglesey, Caernarvon, Merioneth, and Cardigan have been most affected by conditions of purchase in feedstuffs. Denbigh and Flint producers are near to wholesale feed markets, freights are low, purchase is in larger quantities, and selling competition is keen. Producers in other areas have higher freight charges on feeds (are further from markets for produce), and buy feeds in smaller quantities, on the whole at higher prices.

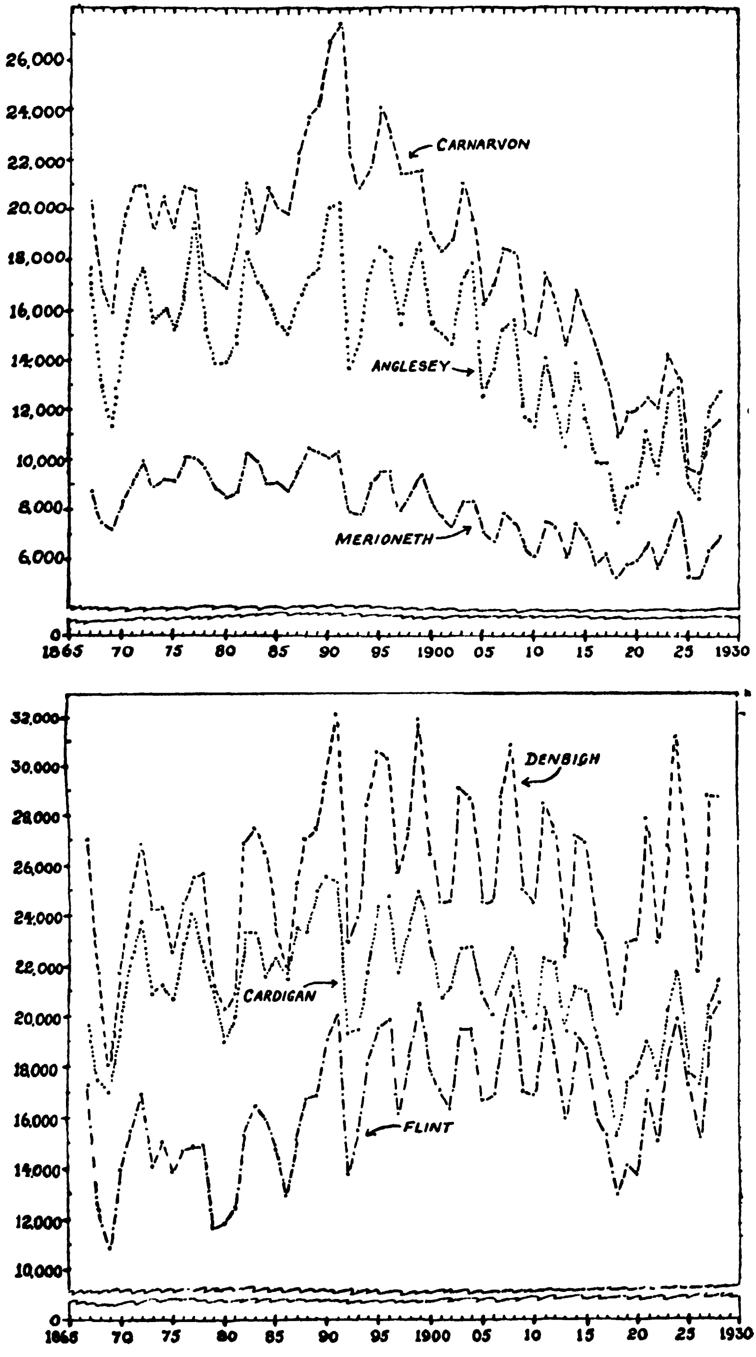
   Where costs of bought feed stuffs in relation to bacon or pork production are not known with any high degree of accuracy, high prices of feeds may themselves exercise a depressing effect on production.

Although conditions relating to markets are similar in Cardigan to those existing in the other counties of North Wales, this county has changed over to porker and cutter production more rapidly and completely than the north-western counties, and this has largely prevented a serious fall in pig population.

On the whole where the trade has been greater and better organised, pig production has been maintained, even increased in Flint. Although this is connected with certain conditions on the farms and on the feedstuffs markets, there is little doubt that

CHART I.

CHANGES IN THE PIG POPULATION, 1865-1929.



the organisation of markets for products has a reflex influence on production itself.

The changes in pig population in three counties showing the heaviest decline and those showing the least decline are shown separately in Chart I.

Variations in the methods and objectives in pig production.

ANGLESEY. Breeding is mainly confined to the medium and larger farms where from one to three sows are kept. Only a few of the pigs bred are fed on these farms; the remainder being sold at from eight to twelve weeks old. Most farms feed from two to ten or twelve pigs in the course of the year. From the larger farms the output of fat pigs tends to be baconers weighing from 12 to 15 score live-weight, and from the smaller farms selling weights vary from 7 to 12 score. Few farmers have a clear objective in mind when weaners enter the sty and practically no attempt is made to turn out 5-6 score porkers, 8-10 score cutters, or bacon pigs from 10-12 score live-weight, and there is little continuity of practice on the same farms. Only on those farms producing heavy baconers is the practice of running the pigs through a store period prevalent. The greater proportion of fat pigs raised in the county consists of heavy porkers and cutters, with a low proportion of baconers. There are also considerable " exports " of stores from the county.

Home grown foods consist largely of potatoes and in some cases pulped mangels are used for sows and stores. Purchased foods consist almost entirely of middlings and maize meal, little if any barley meal being fed.

CAERNARVON. Breeding is confined to medium and large farms in the Lleyn Peninsula and along the costal belt from Caernarvon to Conway. Pigs are bought into the upland areas and it is common practice for cottagers to feed one or two pigs in the thickly populated quarrying areas. In a large number of cases these pigs are slaughtered for home consumption as baconers. Methods of feeding, management and objectives correspond closely with those existing in Anglesey, but in Caernarvonshire a higher proportion of pigs are slaughtered for farm consumption.

MERIONETH. With the exception of Brecon and Radnor, Merioneth has a lower number of pigs per 1,000 acres than any Welsh county. Breeding is confined to the lowlands, but feeding extends well into the upland areas. Management is similar to that outlined for the above counties, but the proportionate slaughter of bacon pigs for home consumption is higher.

There are a few specialised pig farms in the county, otherwise pigs form quite a minor subsidiary enterprise in mixed farming.

DENBIGH. In the north and west, conditions in all respects are similar to those already outlined, but the weaner and store output from this area is considerable. Pig production in the south-east of the county is much more intensive, especially in the Wrexham area, where cheese and bacon production are important enterprises. Some farms in the county may feed up to 100 pigs during the year, but these are not very numerous. With the exception of Flintshire, Denbighshire has the highest density of pigs per 1,000 acres of any county in Wales.

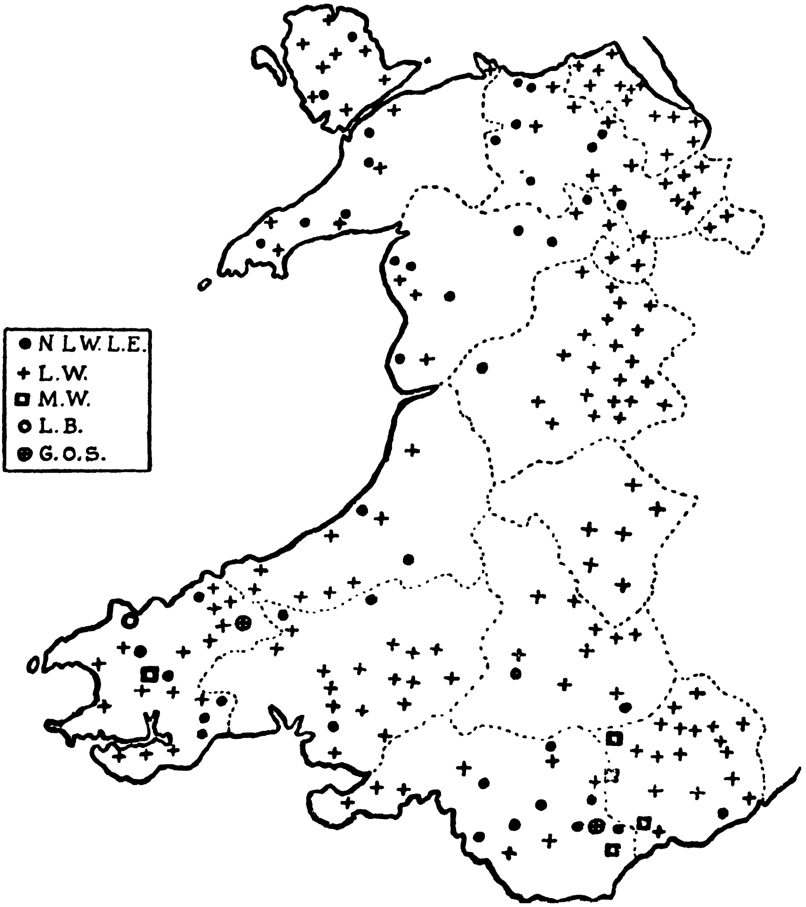
FLINT. This county has the highest density of pigs in Wales. The northern half of the county is mainly a breeding area, and owing to the general practice of producing liquid milk for sale the number of pigs fed varies widely at different periods. Here pigs are used to absorb dairy by-products in periods of surplus production of liquid milk, while on the other hand pigs disappear off the farms when there is an adequate market for liquid milk. The south and east form an intensive feeding area, where pigs and cheese are important products. Store pigs move to this area from the breeding districts of the north of the county. The pig performs different functions in the farming system of different districts. In some cases pigs form a minor subsidiary enterprise, in others they function as shock absorbers in the liquid milk trade, while in the south and east they occupy a position complementary to cheese production. Farm slaughtering in the county is low, and on the decline. Porkers, cutters, and baconers are important products, and more attention is being paid by producers to market weight requirements than in the case of the other counties in North Wales.

CARDIGAN. Pig breeding is fairly well distributed over the county, with the exception of the uplands bordering the county on the east. There is some decline in the intensity of breeding in the north of the county compared with the south. The output in North and Mid-Cardigan consists mainly of stores and bacon pigs, whilst the output from the south and west consists mainly of heavy porkers. Feeding is carried on far more intensively in the southern than in the mid and northern areas. A considerable amount of home grown barley is fed to pigs in this county. Potatoes and swedes are quite commonly cooked for pigs, and it appears that Cardigan uses more home grown foods for pig production than any of the northern counties.

Breeds and breeding.

Except on individual farms, where in a number of cases pure bred pigs have been introduced, it would be difficult to identify typical Welsh farm pigs with a definite modern breed. In type they mainly resemble the National Long White Lop-eared. For a considerable period other breeds, such as the Large White, Middle White, Tamworth, Large Black, and Gloucester Old Spots were introduced, and used probably with little discrimination for crossing with the native lop-eared type. These introduced differences in type and colour which are obvious at the present time in different areas. There had been no concerted effort to improve breeding on a general scale until the introduction of

Distribution of Premium Boars in Wales, 1929.
(Ministry of Agriculture and Fisheries Livestock Improvement Scheme).



the Livestock Improvement Scheme under the direction of the Ministry of Agriculture. Under the scheme the main object is to take into consideration the local type of pig, and to introduce

boars of those breeds which can be reasonably expected to grade up the local types on uniform lines, giving due consideration to conditions on the farm and to modern market demands. Changing breeds at short intervals can only result in rapid mongrelisation when the rate of breeding is so high as in the case of pigs, and as far as possible this practice is prohibited. The foregoing map shows the distribution of premium boars by breeds in each county, and Table II furnishes the numbers on which the chart is based.[1]

TABLE II.

Distribution of premium boars in Wales by breeds and counties, 1929.

	Large White.	*National Large White L.E.*	*Middle White.*	*Glos. Old Spots.*	*Large Black.*	*Total.*
Anglesey ...	8	2	—	—	—	10
Caernarvon ...	6	5	—	—	—	11
Merioneth ...	5	7	—	—	—	12
Denbigh ...	16	8	—	—	—	24
Flint ...	15	—	—	—	—	15
Cardigan ...	8	2	—	—	—	10
Brecon ...	9	2	—	—	—	11
Carmarthen ...	16	3	—	—	—	19
Glamorgan ...	8	8	1	1	—	18
Monmouth ...	17	1	3	—	—	21
Montgomery ...	21	1	—	—	—	22
Pembroke ...	15	6	1	1	1	24
Radnor ...	6	—	—	—	—	6
Totals ...	150	45	5	2	1	203

All along the eastern areas of the border counties there is a heavy concentration of the Large White breed. Throughout the coastal counties of the south, west, and north a minority of Welsh boars are irregularly interspersed with Large Whites. In the number of breeds Pembroke takes first honours, thereby in all probability securing for itself the last place on the market where honours may be represented by substantial cash values.

Four out of the five Middle White boars in Wales are found in the mining valleys on the borders of Glamorgan and Monmouth. There is here a large local market for small pork and the cross-bred pigs are likely to enter the consumers' market directly and not be used for breeding. The inclusion of a solitary Gloucester Old Spot boar in each of the counties of Glamorgan

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[1] The breed statistics have been obtained through the courtesy of the Welsh Department, Ministry of Agriculture.

and Pembroke, and of a single Large Black in the latter county, appears to be a very doubtful proposition in view of its probable effect on the future of breeding and the economics of production.

The Welsh pig is deservedly increasing in popularity, but apparently there are some difficulties in securing an adequate number of boars of uniform high quality to meet the demand. The map gives no indication of the distribution of other (non-premium) boars. Had it been possible to include the latter, Welsh type boars would be in the majority in the coastal counties whilst the Large White would dominate the border counties. From a study of the Agricultural Statistics and records of premium boars, the relation of premium to other boars, and of the number of sows to both classes of boars in North Wales and Cardigan in 1928 was as follows :—

TABLE III.

Number of sows per boar and proportion of premium to total boars, 1928.

County.	*Number of sows per boar kept.*	*Number of sows per premium boar.*	*Premium boars as per cent. of total boars.*
Anglesey ...	25	187	13
Caernarvon ...	20	121	17
Merioneth ...	23	68	34
Denbigh ...	24	157	15
Flint ...	20	171	11
Cardigan ...	28	291	10
Averages ...	23	162	14.4

The number of premiums available for any county cannot bear a strict relationship to the sow population. Much will depend on the standard of the non-premium boars used. Where farmers in some areas use good quality pedigree boars the need for the provision of subsidised boars is lessened, and this influences the position in the different counties.

Premium boars located in areas of dense sow population can also be used more effectively than in such a county as Merioneth, where sows are few and widely scattered. In all the counties shown in Table III, except probably Cardigan, the premium boars would be nearly sufficient for the total sow population without resort to non-premium boars. The only difficulty is that of the accessibility of the boars and the mobilisation of sows. It is probable that motors could be used for the conveyance of sows to boar stations, and this would extend the areas of influence of premium boars, and largely increase their effectiveness in raising the standard of breeding in Wales.

Seasonality of breeding and supplies.

Continuous service records were obtained for 141 premium boars in Wales for the year October, 1927—September, 1928. Services were highest in November for March farrowing and in May for September farrowing, and at their lowest in February and July. Where pigs are bred in specialised commercial herds the seasonality of breeding would be much more emphasised. Services in such herds are usually concentrated into the months of October, November, December, and again in April, May, and June, while there would be practically no services from January to March and July to September. This partial levelling up of services in Wales has the result of levelling up the supply of weaners at six to seven months later and of porkers and baconers at about ten or eleven and thirteen or fourteen months later respectively. The relatively high proportion of winter services for spring farrowing, compared with summer services for winter farrowing, is probably due to the greater importance of the porker and cutter trade relative to bacon, and to heavier losses amongst winter litters. Lower supplies of home grown foods due to less arable cultivation, and lower summer prices for purchased foods, and a larger supply of dairy by-products during the summer months, also influence the determination of periods of farrowing. The lower spring services also indicate that sows in Wales average cosiderably less than two litters a year.

TABLE IV.

Monthly record of service of sows by 141 boars.- 1927–28.

Month.	*Number of services.*	*Per cent. of total.*	*Per boar.*
1927			
October ...	1,127	11.00	8.0
November ...	1,411	13.76	10.0
December ...	1,119	10.91	8.0
1928			
January ...	838	8.17	6.0
February ...	641	6.25	4.6
March ...	848	8.27	6.0
April ...	939	9.15	6.7
May ...	1,105	10.77	7.9
June ...	706	6.88	5.0
July ...	390	3.82	2.8
August ...	494	4.82	3.5
September ...	636	6.20	4.5
Totals ...	10,254	100.00	73.0

Services by individual boars ranged from a total of sixteen to 262 for the year, with an average of seventy-three for the whole of Wales or seventy-seven for North Wales and Cardigan.

The average number of services in individual counties were as follows :—

Anglesey ...	83	Brecon ...	61
Caernarvon ...	71	Carmarthen ...	96
Merioneth ...	83	Glamorgan ...	51
Denbigh ...	81	Monmouth ...	75
Flint ...	60	Montgomery ...	85
Cardigan ...	82	Pembroke ...	54
		Radnor ...	52

II. Marketing of pigs in North Wales and Cardigan.

Methods of selling.

The structure of the organisation for pig marketing differs considerably from the methods adopted for the sale of cattle and sheep in North Wales. The same system does not even apply to different classes of pigs or to the same class of pigs in different districts.

Weaners and stores.

In each county there is one or more market town where this class of pigs is sold from carts on the streets on the weekly or monthly market days. Some municipalities have eliminated this street trading by providing alternative accommodation with suitable pens where the pigs can be properly inspected, but the old system of street selling still remains important in most counties.

In some areas there are dealers who handle nothing but weaners and light stores. These buy whole or part litters from farms, a proportion of which they sell on the streets in the county market centres, while they hawk the remainder in the villages and the countryside. They often supply cottagers with pigs on credit to be paid for at time of sale. Light motor lorries or vans are used for collection and delivery and they operate over fairly wide areas. Such dealers are often buyers on the street markets when conditions of demand and prices on their country rounds are in their favour.

Store pigs are also sold to a considerable extent direct from farm to the feeders. The selling of pigs in regular auction marts is a comparatively recent development in all areas, but the method has made much greater progress in some counties than others. The following data are based on auctioneers' records for the various counties. At least two-thirds of the numbers shown represent store pigs.

In Flintshire only has auction selling gained the ascendancy over all other methods.

County.		*Pigs sold by auction, 1927.*
Flint	...	32,000
Denbigh	...	15,000
Cardigan	...	8,500
Caernarvon	...	5,200
Anglesey	...	3,000
Merioneth	...	960

Fat pigs.

The sale of fat pigs is mainly to dealers on the farms in all the above counties with the exception of Flintshire, where selling in auction marts is equally, or more, important. Some fat pigs are sold in most auction marts, and these mainly supply the local demand. Most dealers employ touts who scout the countryside and provide information as to the quality, number, and location of pigs ready for market. The dealers then visit the farms. It is only rarely that more than one dealer is found to operate in one district, and vendors rarely have more than one avenue of disposal. Often, if the price offered fails to satisfy the farmer, his only alternative is to retain his pigs in the hope that a better price offer is forthcoming in another week or two. Usually dealers are able to give some guidance relating to price prospects for a week of so ahead.

Methods of buying differ according to district and custom. The most common method is to buy on a per pound live-weight basis. Where this method is practised the dealer invariably bases his price on the previous weeks' dead-weight quotations on the Birmingham market for baconers, and in some cases for porkers and cutters. But in a majority of cases dealers' offers for porkers and cutters are based on quotations on those markets into which the pigs are to be consigned. These include Manchester and Liverpool for the extreme North, Wolverhampton and London in areas approaching Mid-Wales, and Cardiff for South Cardigan. Various methods, which give similar results, are used for converting dead-weight into live-weight quotations. Deductions to cover the contents of the digestive tract are customarily made from the registered live-weight, and in many areas the buyer secures his " luck shilling ". Weighing facilities are usually provided by village inns at a nominal charge, and sellers deliver their pigs to the weighing centre. Some dealers may not visit farms, but call at recognised centres on appointed days; vendors in such cases take their pigs to the centre and hope for the best.

In many areas dealers buy overhead on the farms, while other dealers operate on a commission basis. Dealers shipping to English central markets sell through commission agents. One serious disadvantage of the dealer system where payment is made on a live-weight basis is the tendency to fix a flat rate for each week for all weights and qualities of pigs. It is not implied that the practice is invariable, but where it exists, it successfully removes any inducement arising out of price differentiation to improve breeding and feeding and to market pigs at the best weights. Dealers usually take all weights and qualities, but in the long run such accommodation is detrimental to farmers' interests in that they receive little or no instruction relating to specific market demands for definite weights and qualities, and the seasonal changes in the nature of demand.

Transportation and export centres.

Anglesey, Caernarvon, Merioneth and Cardigan have to export their surplus pigs to comparatively distant markets, and, up to the present, consignments to outside markets are made almost entirely by rail. Denbighshire, which is much nearer the Merseyside and Midland markets, is rapidly developing the use of road transportation for the delivery of pigs to these markets. Flintshire has an important store market alongside in Cheshire, and an important fat pig market on the Merseyside and Lancashire, and only a small proportion of its shipments to these markets are made by rail, road vehicles of a small type being widely used.

Centres in each county which consigned more than 250 pigs to outside centres by rail in 1927 were as follows :—

Anglesey.		*Caernarvon.*		*Merioneth.*	
Gaerwen	4,613	Pwllheli	2,091	Corwen	1,132
Llangefni	3,239	Chwilog	2,080	Llanbedr	484
Valley	2,644	Brynkir	1,033	Towyn	381
Llanerchymedd	1,662	Conway	744		
Bodorgan	1,285	Penygroes	494		
Rhosgoch	968	Bettws-y-coed	316		
Menai Bridge	876	Caernarvon	275		
Holland Arms	866				
Ty Croes	844				
Llanfair P.G.	280				

Denbigh.		*Flint.*		*Cardigan.*	
Wrexham	7,044	Mold	2,257	Llandyssul	6,188
Denbigh	4,436	St. Asaph	656	Cardigan	6,103
Abergele	3,150	Rhuddlan	539	Newcastle Emlyn	5,703
Ruthin	2,148	Balderton	408	Llanybyther	4,507
Talycafn	807	Holywell Jct.	354	Lampeter	3,664
Llangollen	746	Rhyl	306	Henllan	3,518
Llanrwst	678			Aberystwyth	2,028
				Tregaron	1,938
				Felinfach	834

Most stations with facilities for handling livestock are used for the removal of pigs from local districts, but in each county there are a few large exporting stations into which pigs are mobilised from the smaller stations in order to make up truck loads and larger consignments.

Seasonality of outward movements.

Although the outward seasonal movements of pigs show similar general variations there are differences between counties at certain periods of the year. Anglesey exports fall from January to April, show a considerable rise through May and June, fall rapidly in July to the lowest point of the year, rise slightly in August, rapidly in September and October, fall in November and rise rapidly in December.

Merioneth exports fall in February, rise in March and April, fall rapidly in May, and decline slowly until July to reach the lowest point. There is a fairly sharp rise in August and a rapid rise in September to October, a sharp decline in November and a rise in December. The difference of approximately two months in the spring bacon selling period between Anglesey and Merioneth appears to be due to the sale of bacon pigs at a younger age in the latter county.

There is a good deal of similarity between Denbigh and Caernarvon in the seasonality of sale except that Caernarvon makes its autumn clearance a month earlier than Denbigh.

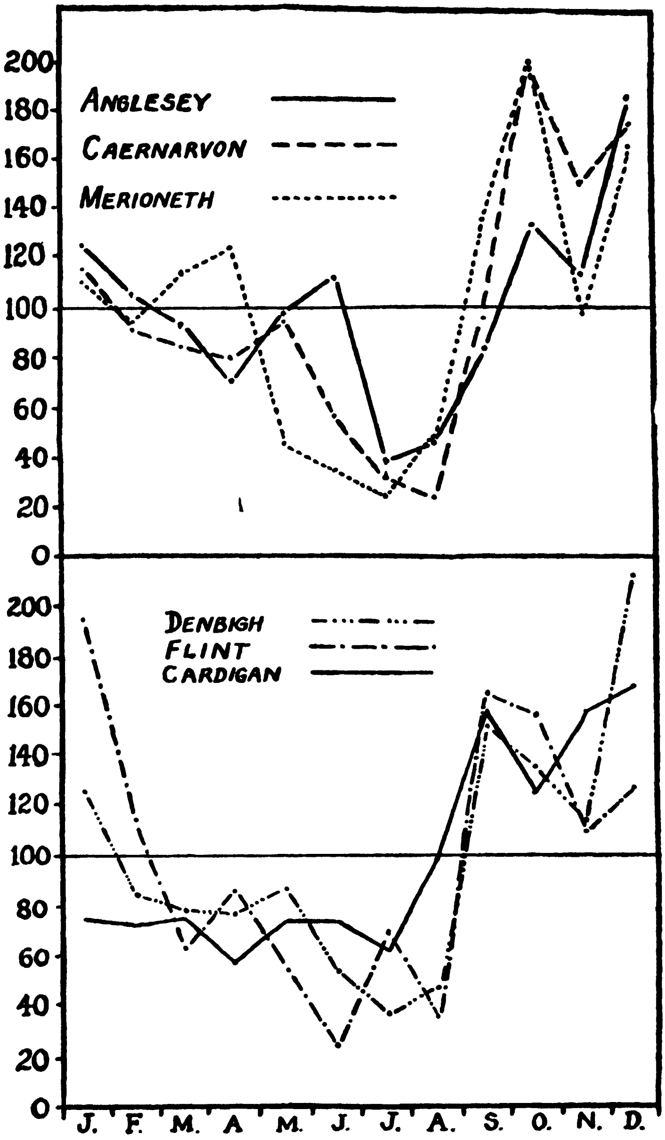
Cardigan differs appreciably from all the others. Except in April, when there is a fall, shipments are maintained at about the same level for the first six months of the year. In July the exports are slightly higher than in April. A rapid rise continues through August and September, followed by a fall in October and a rise from November to December.

Destinations of pigs.

A survey carried out in 1927 gives detailed information relating to the destinations of pigs forwarded by rail to external markets. For Anglesey, the most important fat pig market is in Lancashire, which absorbed 51 per cent. of the numbers exported in 1927. Another fairly important market is found in Derbyshire, but the exports to this county could almost be included with Lancashire as consignments were made into the industrial areas in Derbyshire which are linked up with Lancashire. The most important destinations for store pigs are Ayrshire and Wigtownshire in Scotland, together with Cheshire and Leicestershire.

CHART 2.

DEVIATIONS IN MONTHLY SHIPMENTS OF PIGS BY RAIL, 1927.



For Caernarvon the markets for fat pigs in order of importance are :—Warwickshire (Birmingham) Staffordshire and Lancashire. Cheshire takes most of the store pigs. For Denbigh the fat pig markets in order of importance are :—Lancashire 46 per cent.; Staffordshire 15.4 per cent.; Warwickshire 9.5 per cent. of total export. The most important store markets are Cheshire and the South West of Scotland. Heavy porkers and cutters from Flintshire are marketed mainly in Lancashire, but a fair proportion of Flintshire bacon pigs are marketed in Staffordshire and Warwickshire.

For Merioneth the chief fat pig markets are Staffordshire and Warkickshire, but there is some export to Lancashire. The most important markets for store pigs are in Cheshire, Shropshire and Denbigh.

Cardigan disposes of most of its pigs in South Wales. Its most important English markets are Warwickshire 16.8 per cent., Staffordshire 8.8 per cent., London 8.8 per cent. For store pigs its most important markets are Carmarthen and Shropshire.

For the area as a whole Lancashire is the chief market, but it is followed closely by the Midlands. Cheshire provides by far the largest store market. There is a considerable export of store pigs to the South West of Scotland, and Shropshire takes comparatively large numbers. The North Wales counties dispose of the bulk of their pigs in English markets, but Cardigan disposes of about 70 per cent. of its pigs in the South Wales area.

The following data show the relative importance of markets on a broad basis.

TABLE V.

Destinations of pigs in 1927.

County.	*Disposal areas. Per cent. of total.*		
	English.	*Welsh.*	*Scottish.*
Anglesey ...	80	5.6	14.4
Caernarvon ...	92	7.9	—
Merioneth ...	66.2	33.8	—
Denbigh ...	91.5	3.4	5.1
Flint ...	89.7	6.0	4.3
Cardigan ...	29.2	70.5	0.3

A summary of destinations in comparative detail is furnished in Table VI.

The relative importance of individual markets, excluding those to which less than 1,000 pigs were forwarded during 1927, is indicated below (p. 84).

Summary.

In North Wales the pig population is now on the increase, and there are indications that the pig is likely to occupy a more important part in the farming system in the near future than it has during the last forty years. The war depletion of stock has in most cases already been made up and the policy of farmers in relation to breeding, management, and marketing should be given careful consideration.

TABLE VI.—Despatch of pigs by rail and destinations, 1927.

Destination.	*Source of supply.*						*Total.*
	Anglesey.	*Caer'von.*	*Merioneth.*	*Denbigh.*	*Flint.*	*Cardigan.*	
ENGLAND.							
Lancashire ...	8,960	1,016	181	8,902	1,459	119	20,637
Warwickshire ...	252	3,109	616	1,819	428	5,808	12,032
Cheshire ...	2,750	715	170	2,527	1,489	54	7,705
Staffordshire ...	94	1,756	852	2,948	511	1,318	7,479
Shropshire ...	131	—	195	145	30	1,260	1,761
Middlesex ...	—	—	—	319	113	1,307	1,739
Leicestershire ...	668	—	55	173	70	—	966
Yorkshire ...	276	87	—	299	118	185	965
Derbyshire ...	788	—	—	1	—	—	789
Worcestershire ...	—	1	—	227	11	—	239
Buckinghamshire ...	139	—	—	—	—	—	139
Other Counties ...	39	58	17	182	63	73	432
Total England ...	14,097	6,742	2,086	17,542	4,292	10,124	54,883
Scotland ...	2,525	—	—	983	206	101	3,815
Glamorgan ...	—	—	—	2	—	17,757	17,759
Carmarthen ...	—	—	—	1	—	4,464	4,465
Denbigh ...	36	305	897	—	256	—	1,494
Caernarvon ...	901	—	69	314	28	14	1,326
Monmouth ...	—	—	—	—	—	1,273	1,273
Montgomery ...	—	—	2	3	—	684	689
Flint ...	51	37	47	220	—	—	355
Anglesey ...	—	200	45	30	1	—	276
Brecon ...	—	—	—	—	—	210	210
Merioneth ...	—	35	—	84	2	6	127
Cardigan and Pembroke ...	—	3	7	—	—	—	10
Total ...	988	580	1,067	654	287	24,408	27,984
Total (all destinations) ...	17,610	7,322	3,153	19,179	4,785	34,633	86,682

From the standpoint of breeding North Wales appears to be within measureable distance of a uniformity of production which is so fundamental in pig husbandry. The Welsh and the Large

White breeds provide excellent foundations for the production of heavy porkers and cutters as well as bacon pigs. It is probable that output of porkers and cutters from North Wales will continue to expand, whereas the bacon output may show a further decline,

TABLE VII.

Movements of fat and store pigs.

Destination.	*County of origin.*						
	Anglesey.	*Caer'von.*	*Merioneth.*	*Denbigh.*	*Flint.*	*Cardigan.*	*Total.*
Bacon Pigs.							
Birmingham ...	—	3,109	952	1,679	—	4,063	9,803
Bordesley ...	—	—	516	—	—	1,713	2,229
Porkers and Cutters.							
Cardiff ...	—	—	—	—	—	7,638	7,638
Manchester ...	5,798	—	—	1,526	—	—	7,324
Liverpool ...	549	—	—	3,983	602	—	5,134
Wolverhampton ...	—	—	—	2,664	—	—	2,664
Neath ...	—	—	—	—	—	2,624	2,624
Burton-on-Trent ...	—	1,059	—	—	—	—	1,059
Light Porkers.							
London ...	—	—	—	—	—	1,307	1,307
Stores.							
Pencader ...	—	—	—	—	—	3,467*	3,467
Chester ...	1,433	—	—	1,057	—	—	2,490
Stranraer ...	2,415	—	—	—	—	—	2,415
Tattenhall Road ...	—	—	—	878	971	—	1,849

* Mostly consigned to other areas.

unless the present practice of producing bacon pigs too heavy for the trade is discontinued.

If on the other hand producers pay more attention to supplying the bacon curers with the weights they need, better prices for such pigs may stimulate more bacon production.

The restriction of breeds to the two generally found in the area would appear to be a sound policy, especially if coupled with persistent attention to the improvement of the local type of breeding sows. In those areas where distance from sources of supplies makes an appreciable addition to the cost of feeding stuffs there is considerable scope for an increase in the home production of foodstuffs suitable for pig feeding. If pigs are fed almost entirely on purchased foods they can be most economically produced when fed as near as possible to the central wholesale supply markets, which may also be the consuming market. Good crops of feeding barley can be grown in most areas where pigs are fed in North Wales, but comparatively little is grown. An increase in barley production would tend to render farmers less dependent on purchased foods and thereby remove one of the existing handicaps in pig production.

There is a wide scope for the dissemination of information relating to the modern requirements of markets with regard to types, weights and qualities. Information of this character is lacking in most areas.

From the point of view of marketing the situation is extremely complex. The present lack of organisation of the store market places the store trade in a chaotic and unsatisfactory condition. The street method of selling has undoubtedly long outlived its usefulness, but still continues owing to the lack of other alternative markets in many centres. There is much to be said in favour of establishing special auction sales in areas where a large concentration of store pigs can be obtained, whilst in other areas more attention could be paid to the development of a good store pig section in the present composite auction marts.

The aim should be to centralise as far as possible and to mobilise pigs on a scale large enough to attract buyers and render selling more efficient.

Provided sufficient concentration of fat pigs for sale in English markets could be arranged there are possibilities of eliminating the local dealer together with all the drawbacks of the present system through the establishment of local shipping societies. These could be utilised for the mobilisation, weighing and consignment of pigs to English markets, where sale could take place as at present, through the commission agents, or large areas could be represented by an appointed salesman. There are no particular difficulties in the organisation of such societies, and they could undoubtedly provide producers with an efficient service and, at the same time, provide them with the market information which they lack at the present time and which is such an important factor in the success or otherwise of pig production.

The producers need better market information on supplies required in markets and on ruling prices, but the essential first step towards better or greater production is proper discrimination in prices now offered for pigs of different qualities. In some districts, the proper organisation of markets is almost dependent on greater supplies, better adapted to demands, for part of the unorganised character of markets is due to the unorganised character of production.

SUGAR BEET COSTS IN NORTH WALES.

By J. PRYSE HOWELL, DIP.AGRIC.,
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Up to 1925 little sugar beet had been grown in Wales for commercial purposes. The *Agricultural Statistics* show the following acreages under the crop :—

Year.	*Acres of sugar beet.*
1924	13
1925	40
1926	188
1927	252
1928	192

But in 1925 there was a proposal to establish a factory in Lancashire and in the autumn of that year a number of farmers in North Wales made grower's contracts. Arrangements were then made to obtain records of operations and materials in growing the crop to ascertain the costs and results.

The number of farms from which records have been obtained is shown below.

Each farmer was supplied with a form for recording operations and the quantities of labour and materials used, and each

County.	*1926*	*1927*	*1928*	*Total of Records.*
Flint ...	7	4	7	18
Denbigh ...	10	6	2	18
Caernarvon ...	4	3	—	7
Anglesey ...	3	—	—	3
Montgomery ...	—	—	6	6
Number of records	24	13	15	52

was visited during the season for the purpose of checking, completing and collecting the records. In every case care was taken to get records of quantities.

Certain estimates have to be introduced into the statement of costs. The exact cost of horse labour is not known, and as not all manual labour is paid wages, some manual labour costs are in the nature of estimates. The approximate charges for horse and manual labour in the three seasons were :—

Year.	*Per hour.*	
	Horse.	*Manual.*
	d.	d.
1926	7½	8¾
1927	7½	8⅓
1928	7½	8⅓

The actual hours are given in subsequent Tables, and estimates may be made at other rates per hour.

The charges and credits for other items were made on the following basis :—

Charges.

Tractors : When hired, the actual hiring charge. When belonging to the farm, two-thirds of the hiring charge.

Artificial manures : Actual price, plus cost of delivery to farm.

Farm-yard manure : Farmer's estimate of cost or value.

Credits.

Residual values have been allowed; in the case of manures in accordance with Hall and Voelcker's Tables; and in the case of cultivations one half of the cost of the preparatory cultivations has been carried forward to the succeeding crops. But both gross and net costs are shown. No credit has been allowed for tops, but this item is separately treated below.

Yields, etc.

The yields, tare, and sugar content were obtained from the advice notes sent to each grower by the factories.

Costs and results.

Table I shows the average gross cost and net cost per acre over all farms in each of the years, and Table II the average gross and net cost per ton. There are naturally very considerable variations in costs per acre and per ton and these are discussed below.

TABLE I.

Average costs, yields and returns per acre.

	General Average (1926).	*General Average (1927).*	*General Average (1928).*
Number of costs in group ...	24	13	15
Acres	73.65	39.69	75.5
Per Acre.	£ s. d.	£ s. d.	£ s. d.
Labour (manual, horse, tractor, etc.)	14 8 4	12 11 5	10 11 7
Farm yard manure	2 7 0	2 19 1	1 17 1
Artificial manure and residues from previous crop	5 2 7	3 11 8	3 1 11
Seeds	0 8 4	0 7 3	0 7 6
Rent and rates	2 1 11	2 4 11	2 11 10
Other expenses	0 2 8	0 1 3	0 0 7
Gross farm costs	24 10 10	21 15 7	18 10 6
Railway transport	4 10 3	3 1 0	2 12 2
Total gross cost	29 1 1	24 16 7	21 2 8
Gross price received	29 7 10	21 1 3	16 10 2
Immediate cash results—			
In pocket	0 6 9		
Out of pocket		3 15 4	4 12 6
Deductions from costs for residues carried forward.			
Cultivations	1 18 5	1 15 9	1 11 8
Manures	3 0 2	2 13 0	1 14 8
Total	4 18 7	4 8 9	3 6 4
Profit*	5 5 4	0 13 5	
Loss			1 6 2

* Allowing for residual values of manures and cultivations but excluding tops.

Variations in total costs.

In 1926 the highest gross cost (excluding railway transport) per acre was £36/2/8 and the lowest was £15/2/4. The average cost for all the farms was £24/10/10 per acre.

TABLE II.

Average costs, yields and returns per ton.

	General Average (1926).	*General Average (1927).*	*General Average (1928).*
Number of costs in group ...	23	13	15
Acres	72.4	39.69	75.5
Yield of washed roots (tons) ...	10.32	7.48	6.65
Per ton of washed beet.	£ s. d.	£ s. d.	£ s. d.
Gross farm costs	2 7 0	2 18 2	2 15 6
Railway transport	0 8 8	0 8 3	0 7 10
Total gross cost	2 15 8	3 6 5	3 3 4
Gross price received	2 17 0	2 16 4	2 9 7
Immediate cash results— ...			
In pocket	0 1 4		
Out of pocket		0 10 1	0 13 9
Total sum for residues allowed ...	0 9 5	0 11 10	0 9 11
Profit*	0 10 9	0 1 9	
Loss*			0 3 10
Tare (per cent).	18.1‡	15.6	18.7
Range of average tare for group	12.5 to 32.3	7.7 to 34.3	10.8 to 26.4
Sugar content	16.74	16.38	16.66
Range of average sugar content for group	15.2 to 18.3	15.3 to 18.0	15.0 to 18.9

* Allowing for residual values of manures and cultivations but excluding tops.

‡ 20 farms.

The highest gross cost (excluding railway transport) in 1927 was £35/10/8 per acre and the lowest was £10/18/0 and the average for all farms was £21/15/7 per acre. In 1928, the range of gross costs was from £14/5/0 to £25/11/0, with a general average of £18/10/6 per acre. The lower costs prevailing for the 1928 crop was partly due to larger acreages being grown.

Turning to the cost per ton (excluding railway transport) the highest cost for *twenty-three* farms in 1926 was £3/8/10 and the lowest was £1/9/0. For the thirteen farms in 1927 the average gross cost per ton (less railway transport) was £2/18/2 with a farm range of from £1/18/0 to £8/10/0 per ton. The records for the 1928 crop show an average gross cost of £2/15/6 with a variation of from £1/15/4 to £5/16/4 per ton.

The yields also show fairly wide variations, the lowest in 1926 was 5.6 tons per acre and the highest was 18.9 tons per acre. The average yield for twenty-three farms was 10.82 tons per acre. In 1927 the yields varied from 0.78 tons (where the crop was a failure) to 12.88 tons, with a general average of 7.48 tons per acre. The figures show a further reduction in the yields for the 1928 crop. An average of only 6.65 tons per acre was obtained, the range being from 4.89 to 11.9 tons per acre.

The number of cases falling under the different ranges of costs for the three years of study are given in Table III. In 1926 the most marked concentration of gross farm costs fall within the £24 to £28 per acre group, but in 1927 a slightly lower range of costs prevailed, the concentration of cases falling within the £20 to £24 per acre group. For the 1928 crop, practically the same number of cases fell within each of four groups. For the three years, about 78 per cent. of the costs range from the £16 to £28 per acre.

TABLE III.

Distribution of average costs.

			Number of cases falling within each of the following costs per acre.							
Year.	*No. of farm.*		*£8 to £12.*	*£12 to £16.*	*£16 to £20.*	*£20 to £24.*	*£24 to £28.*	*£28 to £32.*	*£32 to £36.*	*£36 to £40.*
1926	23	Farm costs (excluding railway transport) ...	—	1	5	5	8	2	1	1
1927	13	do. do.	1	—	1	6	3	1	1	—
1928	15	do. do.	—	3	4	4	4	—	—	—
All years	51	do. do.	1	4	10	15	15	3	2	1
1926	23	Net farm costs (after deducting residues), excluding railway transport ...	—	6	9	6	1	1	—	—
1927	13	do. do.	1	3	4	4	1	—	—	—
1928	15	do. do.	1	7	4	3	—	—	—	—
All years	51	do. do.	2	16	17	13	2	1	—	—

When the net costs per acre are considered the whole range of farm costs are lower, and in the case of the 1926 farms the concentration of cases fall within £16 to £20 per acre. For the 1927 farms there is a fairly even distribution of net costs. The concentration of cases for 1928 is within the group cost of £12 to £16 per acre. For the three years 90 per cent. of the net costs fall within the £12 to £24 per acre group.

The single case falling into the £8 to £12 group of net costs in the 1927 farms is due to practical failure of crop and a yield of only 15½ cwts. per acre. The two single net costs occurring within £24 to £28 and £28 to £32 respectively for the 1926 farms were due in the former to fairly high labour and manure expenses and in the latter to a quite abnormal labour cost.

As yields appear to have a considerable influence on the costs perhaps a better test of the efficiency of the various growers can be obtained from a study of the costs per ton. In the case of 1926 crop, the farms have been divided to show the costs of yields under ten tons and those over ten tons. This division of the yields has been selected because it divided the costs into practically two equal groups. For the same reason the division of the cases for those of under eight tons and over has been adopted for the 1927 farms. The same classification has been adopted for the 1928 crop (Table IV).

When the yields of under ten tons and of ten tons and over for the 1926 farms and the yields of under eight tons and over for the 1927 and 1928 farms are considered, it will be noticed that there is a marked tendency for the higher yields to be obtained at a lower cost per ton. For instance, in the group with yields of ten tons and over (1926 farms), ten *gross* costs out of eleven are under 50/- per ton while in the group of lower yields only three out of twelve costs, or 25 per cent., are found to be below that figure. Similarly half of the cases of yield of eight tons and over (1927 farms) are under 50/- per ton while for yields of less than eight tons they are all above this figure. For 1928 over 66 per cent. of cases of *gross* costs on yields of eight tons and over fall within the 50/- per ton group and in the case of the yields of under eight tons over 77 per cent. of the costs are above 50/- per ton.

The same tendency is found with regard to net farm costs for the three years.

Profits and losses.

Of the twenty-four individual farms in 1926 ten showed immediate cash benefits on *gross costs* ranging from 9/- to £20/19/0 per acre; while fourteen show that farmers were for the time

TABLE IV.
Distribution of costs per ton.

Year.	No. of farms.		*Number of cases falling within range of the following costs per ton.*							
			20/- to 30/-	30/- to 40/-	40/- to 50/-	50/- to 60/-	60/- to 70/-	70/- to 80/-	80/- to 90/-	Over 90/-
1926	28	*Gross* farm costs (excluding transport).								
		Yields under 10 tons per acre	—	2	1	5	4	—	—	—
		Yields of 10 tons and over per acre ...	—	7	3	—	1	—	—	—
		All yields	—	9	4	5	5	—	—	—
		Net farm costs (excluding transport), after deducting manurial and cultivation residues.								
		Yields under 10 tons per acre	2	2	7	1	—	—	—	—
		Yields of 10 tons and over per acre ...	4	5	1	1	—	—	—	—
		All yields	6	7	8	2	—	—	—	—
1927	13	*Gross* farm costs (excluding transport).								
		Yields under 8 tons per acre	—	—	—	2	1	1	2	1
		Yields of 8 tons and over per acre ...	—	1	2	3	—	—	—	—
		All yields	—	1	2	5	1	1	2	1
		Net farm costs (excluding transport), after deducting manurial and cultivation residues.								
		Yields under 8 tons per acre	—	—	3	2	1	—	—	1
		Yields of over 8 tons per acre	—	4	2	—	—	—	—	—
		All yields	—	4	5	2	1	—	—	1
1928	15	*Gross* farm costs (excluding transport).								
		Yields under 8 tons per acre	—	—	2	4	2	—	—	1
		Yields of 8 tons and over per acre ...	—	—	4	2	—	—	—	—
		All yields	—	—	6	6	2	—	—	1
		Net farm costs (excluding transport), after deducting manurial and cultivation residues.								
		Yields under 8 tons per acre	—	1	5	2	—	—	—	1
		Yields of over 8 tons per acre	1	4	1	—	—	—	—	—
		All yields	1	5	6	2	—	—	—	1

being out of pocket to amounts ranging from 18/8 to £12/5/8 per acre. Only three out of the ten that showed immediate favourable results had yields of less than eleven tons per acre and these had yields of 9.56, 10.9 and 10.85 tons respectively, while with the exception of one farm all crops that left the farmer out of pocket yielded less than eleven tons per acre.

When the *net* costs are considered nineteen farms made profits ranging from 18/8 to £25/1/1 per acre and of the five which showed losses three of these had yields of less than eight tons per acre.[1]

For the year 1927 only two farms showed immediate cash benefits on the *gross* costs and returns and these were 4/2 and £6/0/1 per acre. Eleven showed that the growers were out of pocket by amounts ranging from 10d. to £12/6/9 per acre. While the yields are low for the majority of the farms, there are two instances of yields of 12.33 and 12.08 tons per acre where no immediate cash benefit was received, but this is due to abnormal labour and transport cost. The two farms that showed the best results had yields of 10.5 and 10.98 tons per acre.

Calculations based on the *net* costs (total costs less residues of cultivations and manures) show that seven of the farms made profits ranging from 7/6 to £10/5/8 per acre[1] and the remainder made losses of from 2/4 to £8/10/0 per acre. Of the seven that showed net profits five had yields of over eight tons per acre and of the six farms which made net losses five had yields of less than seven tons per acre.

With regard to the 1928 farms only three out of the fifteen farms showed immediate cash benefits on *gross costs* and these ranged from 9/4 to £8/4/1 per acre. The yields in these cases were all over eight tons per acre. The other twelve farms show immediate cash losses on *gross costs* ranging from £1/1/9 to £17/10/4 per acre. A comparison of the *net* costs show that eight of the farms made profits of from £1/1/4 to £7/4/7 per acre.[1] Of these farms five had yields of over eight tons per acre and all of the farms showing *net* losses had yields of less than eight tons per acre.

Yield, sugar content and tare.

Reference has already been made to the yields. The average of 10.82 tons per acre in 1926 was very satisfactory as the average yield for the whole of the country in that year was 8.6 tons. Twenty out of the twenty-three farms (or 86.9 per cent.) had yields of over eight tons per acre. The yield in the case of the 1927 farms averaged 7.48 tons per acre and six out of the thirteen farms had yields of less than seven tons. According to the *Agricultural Statistics* (1927) the average yield for England and Wales for the same period did not exceed 6.5 tons per acre.

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[1] These profits or losses are calculated irrespective of allowance of value for tops, whether used for feeding or left for manurial purposes.

The crop obtained in 1928 was disappointing, the average for the costed farms being only 6.6 tons per acre, and this was 1.2 tons less than the average yield for the whole of the country.

The average sugar content of the costed beet in 1926 was 16.74 per cent. and the percentage range was from 15.25 to 18.80. The general average of 17.33 per cent. for the whole country in 1926 is slightly higher than that obtained for the farms under review.

For the thirteen farms (1927) the percentage sugar content varied from 15.3 to 18 per cent. and the general average of 16.38 per cent. was lower than that for the 1926 farms. For the whole of the country in 1927, the average sugar content was 16.13 per cent. A slightly higher percentage sugar content was obtained in the case of the 1928 farms than for the preceding year. The general average being 16.6 per cent., but this is lower than the average of 17.32 per cent. which was obtained for England and Wales in 1928.

The importance of the proportion of the tare to the grower cannot be overestimated, and this is of special significance in the case of the growers in Wales who are handicapped by having to send their beet long distances by rail. The amount of tare on twenty farms in 1926 is high, being on an average 18.1 per cent., and the range is from 7.12 to 32.3 per cent. The unfavourable weather experienced by a number of the growers when the crop was lifted would contribute largely to the results indicated. It has also to be borne in mind that the tare does not consist of dirt alone and that the factory demands that all the beets must be topped squarely below where the lowest leaves have grown and they retain the right to re-top any beets not complying with this condition. While there is no evidence to show that the topping was not properly done on most of the farms, this was found to be the case on three farms where the percentage tare was 32.3, 28.0 and 27.9 respectively.

The percentage tare for the 1927 farms ranged from 7.7 to 34.3 per cent. with a general average of 15.6 per cent.

With regard to the average tare for the whole of the country the *Agricultural Statistics* (1927) states " The wet, sticky conditions of the soil and the fangy nature of the roots made harvesting very difficult, and, in consequence, the roots were delivered to the factories in a dirtier condition than usual, the average tare being about 20 lbs. per cwt. as compared with about 15 lbs. per cwt. in 1926 ".

Tare on the beets of the costed farms in 1928 averaged 18.7 per cent. with a range of from 10.8 to 26.4. This compares unfavourably with the general conditions obtaining in England and Wales. " Harvesting was carried out under satisfactory conditions and resulted in the beet deliveries being much cleaner than in the previous season, the average tare being 14.5 lb. per cwt ".

Tops and leaves.

An indirect advantage of growing sugar beet is the value of the tops and leaves, as these possess high nutritive qualities and constitute a very useful food for farm stock.

As previously stated the beet is topped, and the tops include not only the leaves but also the crown of each root, cut off level with the lowest leaf. These crowns, together with the leaves, the farmer has for his use (for the feeding of livestock or for ploughing them in as green manure), after he has disposed of the saleable part of his crop. Very little information is available as to the quantity of tops and leaves obtained from an acre of beet. About five tons per acre is the figure usually quoted. The estimates given by some of the growers for the three years of study are shown in Table V.

TABLE V.

Production of tops and leaves.

Year 1926.		*Year 1927.*		*Year 1928.*	
No of Farms.	*Loads per Acre.*	*No. of Farms.*	*Loads per Acre.*	*No. of Farms.*	*Loads per Acre.*
1	10	1	18	1	12
2	10	2	8	2	10
3	9	3	11	3	8
4	10	4	10	4	13
5	11	5	5	5	16
6	9	6	10	6	13
7	8	7	10	7	5
8	7	8	8	8	20
		9	10	9	12
		10	8	10	10

The number of loads per acre on the eight farms in 1926 varied from seven to eleven, with an average of 9.25. In 1927, the range was from five to eighteen with an average of 10.8 loads per acre, and in 1928 there was an average of 11.9 loads with variations of from five to twenty loads per acre. Assuming that each load weighs 12 cwts. this gives an average weight of 5.5 tons of tops and leaves in 1926, 6.4 tons in 1927 and 7.1 tons per acre in 1928. The average yield of the washed roots for each year together with the percentage of the tops to the yield is given below.

Year.	*No. of Farms.*	*Yield of Washed Beet per acre.*	*% of Tops to Washed Beet.*
		Tons.	%
1926	8	10.14	55.0
1927	10	8.20	79.0
1928	10	8.60	82.5

From the figures it appears that a higher percentage of tops was obtained in the case of the lower yields. In reference to the 1927 crop, the *Agricultural Statistics* state " the excessive surface moisture caused very fangy growth of the roots and gave rise to excessively luxuriant tops ".

Two farmers who weighed the beet tops in 1927 gave the following returns :—

Weight of Beet Tops per acre.	*Weight of Washed Beet per acre.*	*% of the Beet Tops to Washed Beet.*
Tons.	Tons.	%
4	5.88	68
5	6.29	.79

The methods of disposal of the tops for twenty-two cases in 1926 is shown below, but a few of the farmers used more than one method.

Disposal of tops.

Method of Disposal.	*Number of Cases.*
Left on the ground. Partly ploughed in and partly fed off to stock ...	3
Carted off and fed to stock ...	10
Left on ground and fed to stock ...	9

Only a small number of the farmers used the tops as manure and there is no instance where all the tops were utilised for that purpose. Of the nineteen cases where they were fed to stock these were about equally divided between carting them off and feeding them on the ground. In cases where the tops were fed to dairy cows and other cattle they were usually carted off, but in the case of pigs and sheep they were generally fed on the ground. Similar methods were followed in regard to the utilisation of the beet tops in 1927 and 1928.

The tops were fed to all classes of stock and no actual case was recorded of any ill effects to the animals. All the farmers were quite enthusiastic about the tops as feed and where they were fed to dairy cows it resulted in an increase in the yield of milk.

As regards the value of the tops as compared with other root crops as feed, very few of the growers volunteered any information. The following figures obtained from four of the 1927 growers give the number of acres of roots that they had been able to displace by having the beet tops for feeding.

Acres of Sugar Beet Grown.	*Number of acres of Roots displaced by Beet Tops.*
30	15
10	6
3	2
6	3

Judging by these figures the acres of roots dispensed with is one half the acreage of the sugar beet grown. On this basis an acre of sugar beet tops and leaves is about equivalent to half an acre of roots. In the absence however of more data it is impossible to draw any definite conclusions from these few cases.

Five of the growers gave returns for the amount of keep provided by the beet tops in terms of sheep and on this calculation the result showed that on an average one acre of beet tops maintained thirty-two sheep for about eight days.

A more concrete idea of the nutritive value of beet tops may be gained, however, from the data given in the table below, where it is shown that 40 lbs. of mangels (containing 89.3 per cent. of moisture) are equivalent to 25 lbs. of beet tops (containing 83.8 per cent. of moisture).[2]

From these figures it appears that provided the whole of the tops could be fully utilised, 20 cwts. of sugar beet tops would have the same feeding value as 32 cwts. of mangels. In practice, however, growers experience some difficulty in utilising the whole

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[2] H. E. Woodman, Ph.D., D.Sc. "Notes on Feeding Stuffs for September". Pages 566 and 568. *Journal of Ministry of Agriculture*, September, 1927.

Replaceability of mangels by sugar beet tops.

	Dry Matter	*Starch Equivalent.*	*Digestible Protein*
	lbs.	lbs.	lbs.
40 lbs. Mangels ...	4.30	2.20	0.28
25 lbs. Sugar Beet Tops	4.03	2.14	0.36

of the tops as feed. There is the loss due to the decomposition of the leaves before they can be conveniently fed and wastage on account of a certain amount of dirt contained in the tops, which renders part of the crop unpalatable to livestock. Again, where folding is practised a considerable amount of the fodder is wasted by being trampled into the ground. It is difficult to assess these losses. They must vary from farm to farm and be influenced to a great extent by the methods followed in using the tops. Allowing for these losses, it is probable that the beet tops where they were well managed would be about equal in feeding value to that of mangels.

Pulp.

Another by-product resulting from the growing of sugar beet is the dried pulp which is available at the factory after the sugar has been extracted from the beet. Under contract conditions each grower is allowed to purchase from the factory at special rates up to 5 per cent. of the net weight of the beet delivered. The prices at present is £5 per ton f.o.r. at the factory. In nutritive value 1 lb. of dried pulp would be about equivalent to the same quantity of dried brewers grains or about equal to 8 lbs. of mangolds.

Only a small percentage of the growers availed themselves of the concession offered by the factories. Some of them did not require any pulp, others were disinclined to try a new foodstuff of which they had no previous experience, and another consideration was the heavy freight charges due to the long distances from the factories to the farms.

Variations in costs of certain items.

The costs of cultivating and handling the crop naturally vary from farm to farm. Although the soils would all be described as " two-horse " there are variations from light to heavy two-horse-land. The cleanliness of fields varies from farm to farm, and to some extent from year to year. Harvesting and haulage costs vary with the yield.

On the farmers' costs as stated the variations in costs are considerable.

Variations in costs per acre.

Preparatory Cultivations, first ploughing to drilling.

	High	Low	Average
	£ s. d.	£ s. d.	£ s. d.
1926	9 1 6	1 4 0	3 16 10
1927	5 11 1	1 4 11	3 11 5
1928	9 10 11	1 16 6	3 3 4
Cultivations Drilling to Harvest.			
1926	9 18 9	2 1 6	4 12 11
1927	7 15 9	2 2 6	4 0 3
1928	5 18 3	1 12 0	4 0 8
Singling, Hoeing and Weeding.			
1926	7 19 0	1 5 8	2 19 0
1927	4 18 10	1 0 3	2 11 0
Harvesting.			
1926	4 12 10	0 16 8	2 18 0
1927	4 14 3	0 9 0	2 16 3
1928	5 8 3	1 5 3	2 5 5
Haulage.			
1926	6 2 6	0 18 0	3 0 7
1927	5 7 4	0 4 3	2 3 6
1928	3 0 0	1 2 0	1 17 2

As regards harvesting, haulage, and transport costs, the yearly variations were :—

Costs per ton.

	Yield of Unwashed Beet.	*Harvesting.*	*Haulage.*	*Railway Transport.*	
				Unwashed.	*Washed.*
	Tons.	s. d.	s. d.	s. d.	s. d.
1926	12.56	4 8	4 6	7 2	8 8
1927	8.7	6 5	4 11	7 0	8 3
1928	7.9	5 8	4 9	6 7	7 10

Manures.

In 1926 farm-yard manure was used on twelve farms, and with the exception of one farm, artificials was given to the crop on all the farms. Lime was applied in two cases and compound manure in three cases. On the majority of farms phosphates were given, and this was usually in the form of Superphosphate, except in two cases, where Basic Slag was used, and the dressings varied from 1.8 to 10 cwts. per acre.

The application of Potash was also general—thirteen cases applying Kainit, six giving Muriate of Potash, one Nitrate of Potash and three Sulphate of Potash. The amount applied was from one and a half to about seven cwts. per acre.

Dressing of half a cwt. to 8 cwts. per acre of Nitrate of Soda was applied in seventeen cases, and Sulphate of Ammonia was used on ten farms and doses of half a cwt to 8 cwts. were given. Only in five cases was Bone Manure used and there is one instance where Calcium Cyanamide was given.

The average gross cost of manures in 1926 was £7/8/0 and less residual values £4/5/6 per acre.

The average cost of manures in 1927 for all the farms was £6/10/8 per acre and after deducting the value of manurial residues the net cost was £3/17/8 per acre.

In 1928 on eleven out of the fifteen farms farmyard manure was applied. Special sugar beet manure was applied in nine cases. Very little Kainit or Sulphate of Potash was applied, there being only two cases recorded. Dressing of Superphosphate was applied in four cases, Nitrate of Soda in five, Sulphate of Ammonia in two and there was one case where Bone Manure was used. The cost of manure is less than it was in the preceding years. The average gross cost in 1928 was £4/19/0 per acre and after deducting the manurial residues the net cost was £3/4/4 per acre.

As might be expected, the expenses are higher where farmyard manure is used, and in Table VI it is shown that the total cost for the 1926 crop in the farmyard manure group as compared with farms using artificials only was £8/17/8 per acre as against £5/7/0, and the net cost was £4/9/10 per acre as against £3/5/2. A comparison of the costs of manures for the 1928 crop shows that the gross cost for the farmyard manure group was £6/1/5 and the net cost was £3/14/7 per acre, whereas on the farms where only artificials were applied the gross cost was £3/16/2 and the net cost £2/13/8 per acre.

All the farms with one exception applied farmyard manure in 1927.

TABLE VI.

Results of manuring.

Artificials only.

No. of cases.	*Year.*	*Average yield of beets.*	*Gross cost of manures.*	*Net cost of manures.*	*Cost of manures per ton of beet.*	
					Gross Cost.	*Net Cost.*
		Tons.	£ s. d.	£ s. d.	s. d.	s. d.
1926	12	10.31	5 7 0	3 5 2	10 4	6 4
1928	4	5.41	3 16 0	2 13 8	14 6	9 11

With farm-yard manure and artificials.

Year.	*No. of cases.*	*F.Y.M. per acre.*	*Average yield of beets.*	*Gross cost of manures.*	*Net cost of manures.*	*Cost of manures per ton of beet.*	
						Gross Costs.	*Net Costs.*
		Tons.	Tons.	£ s. d.	£ s. d.	s. d.	s. d.
1926	11	13.3	10.33	8 17 3	4 19 10	17 2	9 8
1928	11	12.7	7.88	6 1 5	3 14 7	15 6	9 6

It will be observed that fairly heavy dressings of farm-yard manure were given, the average being 13.3 tons per acre in 1926 and 12.7 tons in 1928. As far as the yield of the 1926 crop is concerned the yield of beet is about the same for both groups. The results for the 1928 crop shows that the yield for the farm-yard manure group is higher by about 2½ tons per acre.

Seeds.

The expenditure on seed represents but a small item of the total cost of the crop. Seeds are supplied by the factories and sold to the growers at about 6½d. per lb., which is understood to be the cost price. The factory companies favour heavy seeding as this, amongst other things, reduces the risk of poor germination and ensures a regular plant, and they strongly recommend an application of not less than 15 lbs. per acre. For the cases under review the quantity of seed applied ranged from about 10 to 20 lbs., and quite as good yields were often obtained with a light seeding as with a sowing of 15 lbs. per acre or more. The average cost of seed in 1926 was 8/4, in 1927 it was 7/3, and in 1928 it was 7/6 per acre.

Rents and rates.

The average rent and rates in 1926 was £2/1/11 per acre. Rent and rates for the total farms in 1927 averaged £2/4/11 and varied from £1/10/0 to £2/18/0 per acre. With regard to the rent and rates for 1928 these exceed those for the previous years and were on an average £2/11/1 per acre. The farm range was from £1/13/7 to £3/13/6 per acre. While the quality of the soil is responsible to some extent for the difference that exists in the cost, other factors such as the size of the farm, its proximity to towns, markets, etc., also influence this item of cost. It happens in this small group of cases that the higher yields are associated with the lower rents.

No of Cases.	*Year.*	*Average Rent and Rates.*	*Average Yield per Acre.*
		£ s. d.	Tons.
12	1926	2 10 4	9.76
11	1926	1 13 9	10.92
6	1927	2 9 8	6.88
7	1927	1 13 8	9.06
7	1928	3 5 10	6.31
8	1928	2 2 9	8.12

Railway transport.

The method of transporting the beet was by farm transport or by motor lorry to the station and thence by rail to the factory. The costs under this heading refer to the rail freightage of the roots to the factory after they had left the farmers' hands at the station. The erection of a sugar beet factory at Earlestown, Lancashire, as was originally intended, was not proceeded with and practically all the beet was delivered in 1926 to the Kelham factory (Notts). The growers, however, under contract conditions, were only liable for rail transport to Earlestown.

In 1927 a number of the growers delivered their beets to the Ascott Factory at Wellington, Shropshire, and all the beet was railed to this factory in 1928.

With regard to the 1926 transport costs, the general average for that year was £4/10/3 per acre (for twenty-four farms) and 8/8 per ton (for twenty-three farms). The Anglesey and Caernarvonshire growers were at a disadvantage as regards the distance the beet had to be transported and on this account transport costs are higher for these two counties. The average for the Anglesey farms was £6/6/5 per acre and 11/9 per ton and in the case of Caernarvonshire it was £6/15/4 (four farms) per acre and 12/9 (three farms) per ton. The Flintshire farms with an average of £3/9/2 per acre and 7/1 per ton showed the lowest cost and Denbighshire averaged £3/16/4 per acre and 7/6 per ton.

The average costs for all the farms in 1927 was £3/1/0 per acre and 8/3 per ton. Lower transport costs prevailed in 1928, the average being £2/12/2 per acre and 7/10 per ton.

The range of the transport costs per ton for the individual farms for the three years is given below.

The largest number of cases fall within the group of over 6/- and under 7/- per ton. Only three were under 6/- per ton and 24 per cent. of the farms show transport costs of over 10/- per ton.

General conclusions.

The growing of sugar beet on the farms under review does not appear to have competed to any serious extent for labour

Per Ton.	*No. of Cases.*	*% of Total*
Under 5/-	2	4.0
Over 5/- and under 6/-	1	2.0
Over 6/- and under 7/-	20	40.0
Over 7/- and under 8/-	8	16.0
Over 8/- and under 9/-	7	14.0
Over 9/- and under 10/-	0	0.0
Over 10/-	12	24.0
Total	50	100.0

required on the other farm crops. Two instances were recorded where the beet required attention when all the labour was needed for the hay harvest, and there were three cases where it competed for labour with other root crops. One farmer had to employ extra hands because the labour was required for the lifting of the beet and potatoes at the same time. Another case was that where the beet could not be cleared off the ground soon enough to prepare for the sowing of winter wheat. Apart from the cases cited the beet seems to have fitted in with the other crops grown and with the exception of a little casual labour which had to be employed in some instances during the thinning operation or for lifting and loading the beet, the majority of the growers were able to cope with the work on the crop without having to engage any additional labour. On two farms the hauling of the beet to the station was done by contract work. In 1927 there were three farms that had to employ extra hands during singling and harvesting. A higher acreage under beet per farm together with the fact that on some of the farms the beet was grown in addition to the normal root break created a higher demand for casual labour in the case of the 1928 crop and eleven out of the fifteen farms had to employ outside labour during the cleaning and harvesting period. A few of the growers complained that the harvesting of the beet retarded the work on the autumn cultivations and there was one where the beet required attention at a time when all the labour was required for haymaking.

The crops superseded by the sugar beet were as follows :—

Crops.	*1926.*	*1927.*	*1928.*
	No. of Cases.	*No. of Cases.*	*No. of Cases.*
Roots	14	8	9
Potatoes	4	3	0
Corn	5	2	5
Grassland	1	0	1
Totals ...	24	13	15

Displacement of roots is fairly general and probably this decision was made as the deficiency in respect of this crop would be partly compensated for in the value of the sugar beet tops for feeding. Where saleable crops such as potatoes, wheat and barley were chosen to be superseded by beet, the uncertainty of prices to be obtained for these crops would no doubt influence the farmers in their decision. All the growers were of the opinion that the introduction of the sugar beet had made no difference in their system of farming and that it had not affected the stock carrying capacity of the farm in any way.

For the 78.68 acres in 1926 the total capital expenditure in the way of new implements bought for dealing with the best crop was £21/16/6. Four of the growers bought beet lifters which cost about £4 each, two had new attachments made for fixing on to the plough to facilitate the lifting operations, and the cost was £2/2/0. Other new implements bought consisted of sugar beet' forks for loading purposes.

The result of the 1926 enquiry shows that several of the growers made quite satisfactory cash profits on the crop. As none of the farmers had any experience of handling the crop it does seem reasonable to expect that with more knowledge of sowing, cultivating, harvesting and the manuring of the crop that the cost of growing can be reduced. The average labour for the 1926 farms was £14/8/4 per acre and this is found to be higher than the costs in other areas. For instance, the average labour costs on ten farms in the northern counties of England was £10/15/2 and for fifty-three farms in the Eastern and Midland counties was £11/11/9 per acre. Compared with these figures, there does appear to be scope for reducing the costs in this direction on the North Wales farms, even when due consideration is given to the fact that the yields in the English districts were lower.

Compared with 1926 the labour costs have been reduced in 1927 to £12/11/5 and again in 1928 to £10/11/7 per acre on the Welsh farms, but owing to the disappointing yields obtained and a reduction in the grower's price, very few of the farmers were also to show cash profits on the immediate return from the crop, irrespective of the value of tops. It has been shown that the higher yields have been produced at proportionately lower costs and increasing the yields offers possibilities of reducing the costs. One method of attaining this would be to adopt a more intensive cultivation by lessening the distances between the drills, and results have shown that early drilling and singling have resulted in an increase in the yield of beet.

One serious drawback which the growers in Wales have had to contend with is the heavy transport charges. The average in this respect in 1926, 1927 and 1928 was 8/8, 8/8 and 7/10 per ton of washed beet. On this account growers should make every effort to top their beet properly and remove all weeds and other rubbish from their deliveries in order to reduce their freightage costs.

Some concessions have been made by the Sugar Beet Factories Committee with regard to transport cost in respect of the 1929 and 1930 crop, and any cost over 8/- per ton of rail delivery to the factory will not be charged to the growers but will be paid by the factories. This will assist growers, who have had to bear a charge of 10/- per ton or more but will not make much reduction on the average charge here shown.

The financial results for the three years of study are summarised in Table VII.

TABLE VII.

Financial results for 1926, 1927, and 1928.

Year.	*No. of costs.*	*Yield per acre.*	*Sugar content.*	*Gross farm costs including transport.*	*Residual value credit.*	*Net farm costs including transport.*	*Price paid to grower.*	*Net profit.*	*Net loss.*
Per acre.		Tons.	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1926	24	10.32	16.7	29 1 1	4 18 7	24 2 6	29 7 10	5 5 4	
1927	13	7.48	16.3	24 16 7	4 8 9	20 7 10	21 1 3	0 13 5	
1928	15	6.65	16.6	21 2 8	3 6 4	17 16 4	16 10 2		1 6 2
Per ton.				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1926	23			2 15 8	0 9 5	2 6 3	2 17 0	0 10 9	
1927	13			3 6 5	0 11 10	2 14 7	2 16 4	0 1 9	
1928	15			3 3 4	0 9 11	2 13 5	2 9 7		9 3 10

The comparative results for the three years reveal the fact that the yields have decreased each year since 1926 and have fallen off from 10.32 tons in that year to 6.65 tons per acre in 1928. As regards sugar content, the figures show no great variation and remain at about 16.5 per cent. Substantial reductions are to be observed in both the gross and the net costs. In 1926 these were £29/1/1 and £24/2/6 as compared with £24/16/7 and £20/7/10 in 1927 and £21/2/8 and £17/16/4 in 1928. Owing, however, to the disappointing yields obtained and a reduction in the price paid for the beet, the returns to the grower were very much less than they were in 1926. The first year may be regarded as a fairly good year for growing and harvesting the crop under conditions in North Wales, while the second and third years were not so satisfactory.

It is obvious that the economy of this crop in North Wales turns largely upon the eventual recovery of the residual values of manure and cultivations which are carried forward and upon the use of the tops. Recovery of residual values is partly dependent on the subsequent crops and the weather which they enjoy. It appears that good use can be made of the tops, but actual cash returns from these are naturally difficult to ascertain.

It has always to be recognised, however, that certain farmers whose beet crop might show losses on such bases of costs and returns as have been used above may still continue to grow beet with satisfaction to themselves. While horses and manual workers are on the farm, whether the beet crop is grown or not, there is not necessarily any considerable increase in total expenses as a result of growing the crop. The receipt of extra cash returns from this cash crop may then be important to the individual farmer. If the alternative is an ordinary farm root crop, the cash returns from beet are immediate and much more direct than in the case of swedes and mangels, and they may even be higher than the returns from swedes. The farmer is certain of his market for beet and is certain of price, and subject to variations in yields is certain of returns.

APPENDIX.

For the purpose of discovering the effect of different rates of charge for horse and manual labour, the following Tables have been drawn up. The basis of charge for horse labour is here 6d. per hour and that for manual labour 7½d. per hour. The actual hours worked in various groups of operations are stated, but not the hours for individual operations such as once ploughing or once hoeing (Table I).

APPENDIX TABLE I.—Labour costs at standard charges, 1926, 1927, and 1928.

Year, 1926. No. of costs, 23. Acres, 72.4.	*Horse labour.*		*Manual labour.*		*Tractor.*	*Motor.*	*Total.*
Per acre.	Hours.	£ s. d.	Hours.	£ s. d.	£ s. d.		£ s. d.
Preparatory cultivation up to drilling ...	61	1 10 6	44	1 7 6	0 7 1		3 5 1
Cultivations from drilling to harvest ...	26	0 13 0	108	3 7 6	0 1 2		4 1 8
Harvesting	5	0 2 6	79	2 9 5			2 11 11
Haulage	42	1 1 0	42	1 6 3			2 7 3
Total labour	134	3 7 0	273	8 10 8	0 8 3		12 5 11
Year, 1927. No. of costs, 13. Acres, 39.69.	*Horse labour.*		*Manual labour.*		*Tractor.*	*Motor.*	*Total.*
Per acre.	Hours.	£ s. d.	Hours.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Preparatory cultivation up to drilling ...	56	1 8 0	43	1 6 10	0 4 8		2 19 6
Cultivations from drilling to harvest ...	27	0 13 6	88	2 15 0			3 8 6
Harvesting	8	0 4 0	62	1 18 9			2 2 9
Haulage	28	0 14 0	47	1 9 5		0 3 4	2 6 9
Total labour	119	2 19 6	240	7 10 0	0 4 8	0 3 4	10 17 6
Year, 1928. No. of costs, 15. Acres, 75.5.	*Horse labour.*		*Manual labour.*		*Tractor.*	*Motor.*	*Total.*
Per acre.	Hours.	£ s. d.	Hours.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Preparatory cultivation up to drilling ...	56	1 8 0	42	1 6 3	0 1 0		2 15 8
Cultivations from drilling to harvest ...	25	0 12 6	73	2 5 7			2 18 1
Harvesting	8	0 4 0	57	1 15 8			1 19 8
Haulage	23	0 11 6	24	0 15 0		0 5 8	1 12 2
Total labour	112	2 16 0	196	6 2 6	0 1 0	0 5 8	9 5 2

From Table II it will be seen that in spite of this reduction in the estimate of labour costs, the 1928 crop still showed a small estimated loss. In other years the effect of reducing the charge for horse labour is to increase the estimate of profit.

Profits and losses on different cost bases.

		Profits. 1926.	*Profits. 1927.*	*Losses. 1928.*
As on costs at Farmers' estimate.		£ s. d.	£ s. d.	£ s. d.
	Per acre.	5 5 4	0 13 5	1 6 2
	Per ton.	0 10 9	0 1 9	0 3 10
As on costs on revised estimate.		£ s. d.	£ s. d.	£ s. d.
	Per acre.	7 8 10	2 1 4	0 3 0
	Per ton.	0 14 6	0 5 6	0 0 6

APPENDIX TABLE II.

Estimate of costs, yields and returns on standard charges for labour, 1926, 1927, and 1928.

Year	1926	1927	1928
Number of costs	23	13	15
Acres	72.4	39.69	75.5
Per acre.	£ s. d.	£ s. d.	£ s. d.
Labour (horse, manual and tractor)	12 5 11	10 17 6	9 5 2
All other expenses, including railway transport	14 3 6	12 5 2	10 10 4
	26 9 5	23 2 8	19 15 6
Gross price received	29 8 0	21 1 3	16 10 2
Immediate cash results—			
In pocket	2 18 7		
Out of pocket		2 1 5	3 5 4
Deductions for residues carried forward	4 10 3	4 2 9	3 2 4
Profit*	7 8 10	2 1 4	
Loss*			0 3 0
Yield of washed roots (tons) ...	10.32	7.48	6.65
Per ton of washed beet.			
Total gross costs, including railway transport	£ s. d. 2 11 3	£ s. d. 3 1 10	£ s. d. 2 19 5
Gross price received	2 17 0	2 16 4	2 9 7
Immediate cash results—			
In pocket	0 5 9		
Out of pocket		0 5 6	0 9 10
Total sum for residues allowed ...	0 8 9	0 11 0	0 9 4
Profit*	0 14 6	0 5 6	
Loss*			0 0 6

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* Allowing for residual value of manures and cultivations but excluding tops.

THE COMPARATIVE TREND OF PRICES OF BRITISH AND IMPORTED DAIRY PRODUCTS.

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The production of butter and cheese are important aspects of the dairy industry in England and Wales. Butter making is general on the stock raising farms of Wales, whereas farm cheese production is a feature of agriculture in the border areas of Denbigh, Flint and Montgomeryshire. The following table shows the disposal of milk (excluding milk fed to calves and pigs) in the two agricultural divisions of Wales, with comparisons for England and Wales.[1]

TABLE I.
Use of milk per 1,000 gallons.

	Sold off farms in terms of milk.					*Farm and household consumption.*
	Milk.	*Butter.*	*Cheese.*	*Cream.*	*Total.*	
North Wales ...	485	208	108	2	802	198
South Wales ...	491	262	5	1	762	238
England and Wales	733	119	48	6	906	94

Both butter and cheese have to meet the competition of imported supplies in the consuming markets of this country. A study of the prices of these products, according to their origin, is therefore a matter of great importance to the home producer.

British and imported butter prices.[2]

For the period 1906 to 1928 there are reliable statistics of the values of home produced and imported butter. Unfortunately it was found impossible to secure quotations for Irish butter between 1920 and 1926 owing to the effect of internal troubles.

Table II shows that with the exception of two years, the prices of first quality British butter were higher than those of imported butter throughout the period. Conditions between 1915 and 1920 were abnormal, due to the submarine menace until 1918, and to the control of prices which was maintained until 1920.

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[1] The Fluid Milk Market. *Economic Series*, No. 16. Ministry of Agriculture.

[2] The term " British " in this article refers to home produced butter and cheese.

TABLE II.

Prices of first quality British and imported butter, 1906–1928.

Year.	*Price per hundredweight.*					
	British.	*Danish.*	*Irish "creamery."*	*New Zealand.*	*Australian.*	*Irish "factory."*
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1906	133 0	118 6	111 6	111 0	108 0	99 0
1907	128 4	114 6	108 6	107 0	103 0	96 0
1908	132 3	121 6	116 0	118 0	116 0	106 0
1909	130 8	118 6	111 6	111 6	108 0	101 0
1910	132 3	120 0	112 0	116 0	112 8	103 6
1911	134 7	124 6	119 0	114 6	114 0	104 6
1912	135 4	130 0	119 0	123 0	119 0	111 6
1913	134 7	127 0	117 0	120 0	114 6	104 0
1914	136 1	130 6	122 6	122 6	119 0	110 6
1915	156 4	161 6	154 6	148 0	144 6	137 6
1916	182 0	187 0	182 6	179 0	169 6	156 0
1917*	231 9	214 0	214 0	214 0	209 6	199 6
1918*	263 8	248 0	248 0	248 0	248 0	248 0
1919*	270 8	252 0	252 0	252 0	252 0	252 0
1920*	403 8	300 0	300 0	300 0	300 0	300 0
1921	304 1	257 6	—	—	234 0	—
1922	223 3	203 6	—	192 0	183 0	—
1923	217 9	196 6	—	191 0	184 6	—
1924	224 9	216 6	—	199 6	189 6	—
1925	228 8	214 6	—	191 6	184 0	—
1926	210 0	185 0	167 0	172 6	169 6	150 0
1927	200 8	184 0	172 6	172 0	169 6	149 0
1928	213 11	192 6	182 6	179 0	171 0	161 0

* Prices of butter controlled.

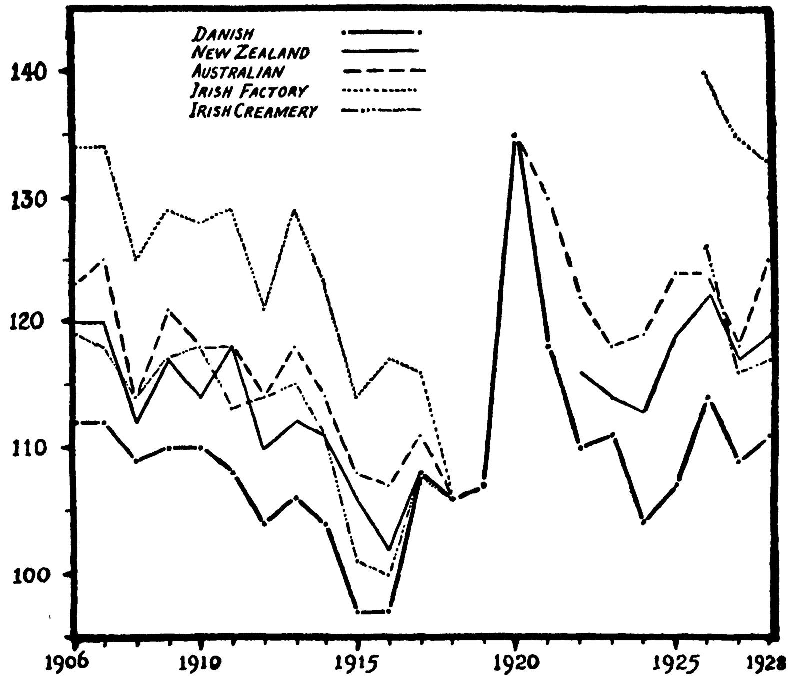
First quality Danish butter sold for more than first quality British in 1915 and 1916, and in the latter year, Irish "creamery", was also dearer than British. Supplies from both these countries commanded higher values because of the fears of a food shortage resulting from enemy blockade. In the case of Denmark an actual decrease in imports occurred and this was partly attributable to the demands made by Germany on Danish supplies.

The control of prices of all butter from 1917 to 1920 also had a disturbing effect on values. The table shows that the control of prices resulted in equalising the values of imported supplies, irrespective of the country of origin. There is little doubt that the effect of this was to give an artificial stimulus to the prices of home produce. The high level of all prices in 1920 contributed to putting a higher premium on home supplies than at any time between 1906 and 1928.

The significant fact about the trend of relative values is that from 1906 to about 1915 the price margin between imported and home-produced butter became narrower. This is shown clearly in the preceeding table, and in the accompanying Graph. It is also seen that the pre-war tendency has reasserted itself since 1920, especially as regards Danish butter.

CHART 1.

Ratios of British butter prices to prices of imported butter, 1906–28.



(The values plotted in this chart are obtained by giving a value of 100 to prices of produce other than British, and then finding the percentage of the British price to the others. Quotients above 100 show a premium on British produce and values below 100 show it to be at a discount. The same method is adopted in Chart 2).

Denmark, Ireland, New Zealand, and Australia form the principal sources of butter imported into Great Britain. The lowest butter price ratio, *i.e.*, the highest price in relation to that of British butter, is obtained by Danish butter. Irish " creamery ", New Zealand, Australian, and Irish " factory " butter follow in descending order of prices. The differences in price between the various kinds of imported butter may be attributed largely to differences in quality, but the regularity of shipments is an important factor in determining the favourable position held by Denmark.

Danish, Irish " creamery ", New Zealand and Australian butters are all the production of creamery effort of one kind or another. As such, they differ but little in quality and price, and the final choice by the consumer is frequently a matter of personal preference or prejudice. Irish "factory" butter falls into a somewhat different category. A considerable quantity of Irish butter is still made on the farm rather than at the creamery. This butter has, naturally, a somewhat wide variability in quality and is sold in lump form to be blended in the factory into a more homogeneous and marketable product. The resulting product, known as "factory" butter, is inferior in quality to that produced from whole milk at the creamery, and usually receives the lowest price of the more important types of imported butter on the markets of Great Britain.

The diminishing premium on home-produced butter is largely explained by the persistence of farm production in Great Britain. This system of production does not yield that degree of uniformity and standardisation which is attainable when production is concentrated, as in exporting countries, in the creameries and factories. The development of collective production has probably been hindered by the relatively low return on milk made into butter. For some years butter-making in England and Wales has been the least profitable form of dairy-farming. It is not generally practiced on a large scale but frequently forms the outlet for surplus milk from areas remote from the liquid milk market. Butter-making, however, is an important means of utilising the irregular milk supply on stock raising farms. Most of the butter is made on the farm by family labour, sometimes highly skilled, but more often of low efficiency. Little effort has been made to secure regularity in the quality or the quantity of production, although knowledge of the technique of handling milk is becoming more general. But it must be admitted that, under present conditions, much of the home-produced butter is poor in quality, and that a great part of it is produced and marketed in an unsatisfactory manner. It is very doubtful whether general and permanent improvement is possible with the continuation of farm production. It would be folly to suggest that butter-making, under British conditions, can be made as profitable as other forms of dairying. But the fact that good British butter almost invariably commands a better price than the best imported supplies, makes it evident that improved methods of production and marketing would secure for the British butter-maker a better return than he is now receiving.

British and imported cheese prices.

The relative prices of home-produced Cheddar and Cheshire,

and imported Canadian and New Zealand cheese have undergone considerable change during the last twenty to twenty-five years (Table III). Generally speaking, Cheddar cheese has maintained a price advantage over the other types throughout the period, but the price ratios have been far from constant.

TABLE III.

Prices and price ratios of domestic and imported cheese, 1906–1928.

	Price per hundredweight.								*Ratio of British Cheddar to*		
Year.	*Cheddar.*		*Cheshire.**		*Canadian.*		*New Zealand.*		*Cheshire.*	*Canadian.*	*New Zealand.†*
	s.	d.	s.	d.	s.	d.	s.	d.			
1906	75	6	66	9	52	6			113	121	
1907	78	6	64	5	63	0			122	125	
1908	74	6	61	7	62	0			121	120	
1909	75	6	64	5	61	0			117	124	
1910	74	6	62	1	59	0			120	126	
1911	79	0	66	8	64	6			119	123	
1912	82	0	64	10	70	0			126	117	
1913	76	0	63	11	65	0			120	118	
1914	82	0	65	9	72	0			125	114	
1915	97	0	83	1	88	0			117	110	
1916	115	6	106	5	107	0			109	108	
1917	152	0	141	5	144	6			108	105	
1918‡	163	6	—		145	0			—	113	
1919‡	150	0	—		149	0			—	101	
1920‡	178	6	209	6	163	6			85	109	
1921	158	6	165	0	132	6	132	0	96	120	120
1922	132	6	119	0	102	0	99	0	111	130	134
1923	135	6	123	6	115	0	118	0	110	118	115
1924	133	6	111	6	99	0	96	6	120	135	138
1925	135	0	117	6	109	0	107	6	115	124	126
1926	125	0	96	6	99	0	95	6	130	126	130
1927	120	0	97	0	99	6	95	0	124	121	126
1928	133	6	116	6	111	0	106	6	115	120	125

* Average price at Chester, Whitchurch, and Nantwich cheese-fairs. Not quoted in 1918 and 1919.

† It has not been possible to obtain price quotations for first quality New Zealand cheese for the years 1906-1920. But the declared values at ports of all New Zealand cheese are obtainable and these statistics are shown below. The price ratio of British Cheddar cheese to the declared values is also shown for the period.

‡ Cheese prices controlled.

From about 1910 to 1917 Canadian cheese was advancing in price relative to the prices of domestic cheese. As in the case of imported butter, greater uniformity and dependability of quality were gradually influencing the demand for the imported product. During the early years of the War cheese consumption increased. Cheese was widely advocated as an economic food in a time of

Year.	*Declared values of New Zealand cheese per cwt.*		*Ratio of British Cheddar to declared value of New Zealand cheese.*
	s.	d.	
1906	58	9	129
1907	61	0	129
1908	60	5	123
1909	60	5	125
1910	57	9	129
1911	60	9	130
1912	69	3	118
1913	61	7	123
1914	65	6	125
1915	87	8	111
1916	100	6	115
1917	131	3	116
1918	126	1	129
1919	136	5	110
1920	146	2	122

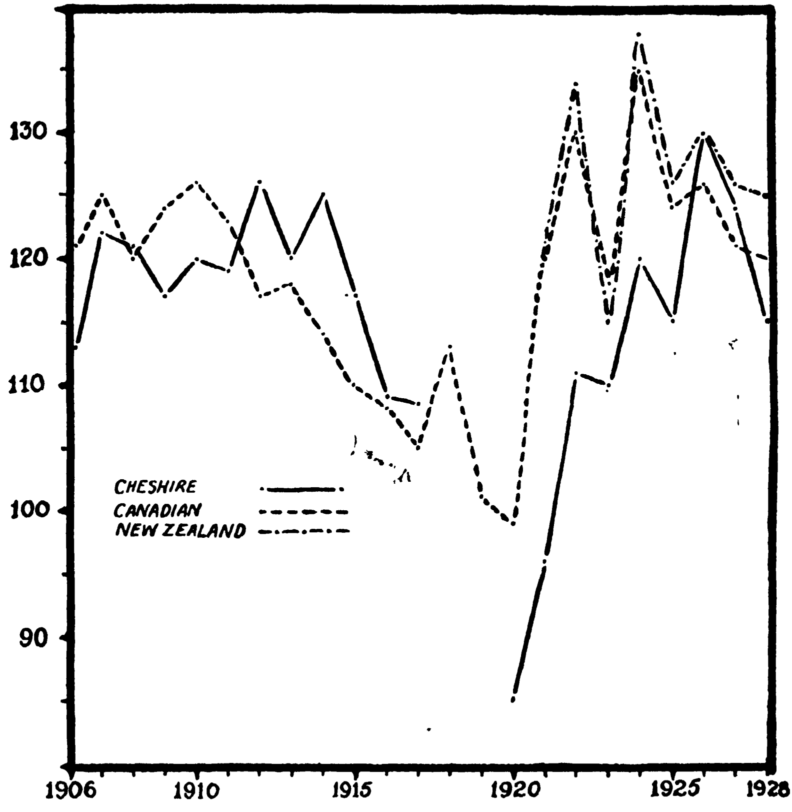
food shortage, and to a much greater extent than formerly became a substitute for meat in the diet. Although the volume of import was kept up to normal in spite of the difficulties and dangers of war-time navigation, the increase in consumption caused the relative rise in price of imported cheese to continue more rapidly than before. This rise was checked by the control of cheese prices in 1918, 1919, and 1920. Since the war, and the release of prices from control, the price of imported Canadian cheese in relation to the price of Cheddar cheese has returned to its pre-war position.

This can be explained partly by some decrease in consumption as the scarcity of food passed away, but more on account of greater competition on the part of New Zealand cheese. Heavy imports from New Zealand are a post-war development. Now she is Britain's largest supplier, and in every year since 1920 has exported more cheese to this country than Canada. Since 1920 these two countries have contributed 85 per cent. of the total imports.

While in most years Canadian cheese commands a higher price than New Zealand supplies, the latter have certainly tended to depress Canadian prices during some months of the year. The heavy shipments of Canadian cheese are made from July to December while the bulk of the New Zealand cheese arrives in the period January to August. In July and December there is keen competition between supplies from the two countries, and New Zealand seems to be consolidating her position by levelling up her exports a good deal more than Canada. She is fortunate in being able to put the bulk of her produce on the market at a time of the year when Canadian imports to Britain are low and when home production is light.

CHART 2.

Ratios of Cheddar cheese prices to prices of Cheshire and imported cheese, 1906–28.



Cheddar cheese normally commands a higher price than Cheshire cheese. This is the result partly of the greater standardisation in Cheddar cheese manufacture and partly of a difference in the class of consumer. The former is now mainly the product of surplus milk utilisation by the big milk dealers, while Cheshire cheese is still a farm-manufactured product, the quality of which varies considerably from farm to farm and from time to time. Cheddar cheese finds its main centre of consumption in London and the South of England, whereas Cheshire cheese forms one of the main articles of diet for the mining and industrial population of the North. The actual price difference, however, is not so great as Chart 2 would indicate. The Cheddar cheese prices, used in computation of the Cheddar-Cheshire cheese price ratio, are wholesale city prices, while the Cheshire cheese prices quoted are average cheese-fair prices at Chester, Nantwich, and Whitchurch. They are practically farm prices plus the cost of the five to ten miles of road haul to the local cheese fair.

When the War began Cheshire cheese prices advanced more rapidly than those of Cheddar cheese. Two factors exercised their influence here. The increased war-time consumption tended to be greatest in this type of cheese and this increased its relative price. At the same time, the prices used here incorporate the tendency for farm prices to rise more rapidly than city prices. This intensifies the natural increase in the price of Cheshire cheese. Towards the end of the War, patriotic endeavour and the lure of high prices induced many farmers in remote districts to inaugurate co-operative cheese factories. Most of these small associations were concerned with the manufacture of Cheshire cheese. The decline in Cheshire cheese prices at the time of the general price slump proved one of the main causes of the collapse of co-operative cheese manufacture in Wales. What promised at one time to be a revolutionary development in the marketing of British dairy products was prematurely throttled and only a handful of the better managed co-operatives survive.

The price movements discussed above indicate very largely the advantages of standardisation of quality enjoyed by our overseas competitors. This is the direction in which home produce must be improved if it is to retain its position in the home market.

TYPES OF MOUNTAIN AND HILL SHEEP IN WALES.

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The hill sheep farmers of Wales are essentially intermediate producers. While a small number control and use land of varying qualities, some of which is suitable for fattening, the majority of them are selling store lambs, prime draft ewes, or young wethers, or a combination of these. Those who are selling draft ewes require a great part or the whole supply of ewe-lambs to maintain their ewe flock, but they sell the wether lambs in their first autumn or as wethers in the following year. Those who sell mainly lambs are able to keep their breeding ewes as a permanent flock with the normal replenishment, and sell the greater part of the ewe with the wether lambs. The culled ewes are, of course, also sold. But there are many variations in the proportions in which ewe lambs, wether lambs, prime draft ewes, and young wethers make up the total sales of sheep from mountain and hill farms. In general, the common condition is that all the flockmasters are turning out sheep for the further use of other farmers.

In the determination of their breeding policies they have to consider their markets and the natural conditions under which their flocks are kept, especially the altitude and exposure of the sheep-walks and the quality or qualities of the pastures available. They are never free agents in the selection of breeds or crosses to meet market demands, for on the whole the consideration of natural conditions and the ability of the sheep to thrive under them must predominate in their choice of breeding stock.

The flockmasters of the higher sheep-walks, except when they also use or control lowland pastures, have little direct contact with the final markets to which their sheep or their products are sent. Their ewes go to the lowlands for fat lamb production, and the lowland farmers use them for crossing with rams of Down or other breeds as they see fit, according to their local farm and market conditions. The mountain and hill lambs and wethers also go to the lowlands for fattening.

Through the markets and fairs the hill farmers obtain information as to the requirements of the users of their sheep, and by various indirect means they obtain some information about the requirements of consumers' markets. As a result of knowledge gained and opinions formed in various ways, there are attempts to adapt breeding policies to market conditions so far as that may be possible. In the earlier selling of wethers, or the substitution of sale of lambs for wethers, and in the catering for the lowland markets for ewes to be used for fat-lamb production, they have followed market conditions. It was within their power to make these changes with whatever breed or type of sheep they used, but it is not always possible to follow market conditions or preferences in the use of breeds and crosses.

The predominant mountain breeds which exist in Wales today are the Welsh, Kerry, Cheviot, Radnor and Scotch Blackface. While these retain their pure-breed characteristics in specific areas, a certain amount of cross-breeding takes place in certain other areas. The Welsh Mountain is without doubt numerically strongest and can be found in almost every county on land over 1,000 feet high. It is the original mountain breed and still retains its importance. Historical references are usually limited to a few lines which emphasise the inferior quality of the wool, and the almost unequalled quality of the mutton, together with its diminutive frame. The breed maintains its importance because of its hardiness and marked ability to find sufficient to maintain itself on the most barren of hills. On the common lands where there are no effective limits to the number than can be turned in for grazing, no sheep is better suited to undertake this struggle for existence. In an essay written in 1866 H. M. Dixon states[1] " Still even in N. Wales . . . there are many mountains on which no cross bred could live, except were it a union of native and Herdwick. The Welsh are undisputed masters of the situation above 2,500 feet and . . . will thrive as of yore in those rocky cloud-capt heights where nothing else save a goat would climb ". This writer seemed to have erred on the side of safety, for only in limited areas over 1,000 feet above sea level has the superiority of the Welsh mountain sheep been challenged, and it still reigns supreme in many districts of lower altitude.

In the Prescelly Mountain area of Pembrokeshire the native sheep show some slight variations from the Welsh Mountain type. While they are about the same size they tend more markedly to brown and in some flocks to dark-brown face and leg markings. There is some doubt as to the extent to which this is due to crossing, but there cannot be any doubt that there has been crossing in a number of flocks or that some of the results remain. The chief economic difference claimed by flockmasters for the Prescelly type over the ordinary Welsh Mountain type is that the wool is of slightly finer quality. This may be one of the results of past crossing, or it may be due to soil and climatic conditions which are more favourable to wool production than those of more northerly hill regions.

The Kerry Hill sheep, another native breed, are somewhat more localised than the Welsh breed. They are found on their native hills in Montgomeryshire and also in the border counties of Brecon and Radnor. Under the influence of a very active Flock Book Society considerable changes have taken place in the general type which has been popularised. For lowland and lower hill conditions and in breeding rams for crossing these changes represent improvements, but the smaller, more compact, and hardier, earlier type of the breed are preferred for the higher and poorer hill conditions. The breed generally, and the improved rams particularly, are used in many districts for fat lamb production. However, the small unimproved mountain ewes are still in demand for crossing with Down rams on the lowlands and many are used in flying flocks in North Wales. These ewes are hardy, easily maintained and have not the same tendency to ramble in a strange country as the Welsh mountain ewe and are thus more popular than the latter on badly-fenced lowland farms.

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[1] Vol. II, Second Series, *Journ. R.A.S.E.*, 1866, page 377.

The Cheviot breed seems to have established itself in South Breconshire since the earlier portion of the latter half of the nineteenth century. The above mentioned writer does not mention the Cheviot in his essay, but in 1884, writing on the " Agriculture of Glamorganshire ", Little[2] mentions the failure of north country men to subtitute Cheviots and Cheviot crosses for the native sheep after buying experience somewhat dearly. " Cheviot crosses have succeeded better on the more grassy hills of Brecknockshire which lie on the Old Red Sandstone but they rarely succeed on hills lying on the Coal Measures ". At the present time the size and type of sheep in this district almost coincides with the geological formation, the Cheviot and the Radnor being found on the Old Red Stone but the Welsh are still retained on the less productive formations. It is interesting to note here that any attempt to replace the native breed by any other types or breeds of mountain sheep can usually be traced to personal elements. Flockmasters or shepherds with experience of other and larger breeds of sheep when taking over a sheep-walk on the Welsh hills are not content to produce the small native animals, and both in North and South Wales there are records of attempts made to replace them with larger sheep. In South Breconshire the replacement has met with a considerable amount of success due to the fact that in the district there are superior pastures. A well-known sheep farmer in the district who could without doubt speak with authority, told the writer that the Breconshire Hills were equal, if not superior, in quality to any sheep-walks in Great Britain.

A serious rival to the Cheviot breed in this district is the Radnor. As a breed it is not particularly well known and few modern textbooks include it as a specific breed in their enumerations and descriptions. It does, however, possess certain characteristics which permit of its being recognised as a separate breed, and the recent reorganisation of the Radnor Flock Book Society will have a pronounced effect on its resuscitation. Writing on the Radnor breed in 1877, Morgan Evans[3] states that they " are short legged and active, hardy when exposed to severe weather ". Referring to the improved Radnor he says " it is a superior animal to the white faced Cardiganshire sheep, and to its remote ancestors, and requires a somewhat better climate and herbage ". To-day the breed is localised in Breconshire and

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[2] *Journ. R.A.S.E.*, Second Series, Vol. 21, 1885, page 189.

[3] Sheep and Pigs of Great Britain.

Radnorshire and does not compete with the Welsh mountain. It is a larger breed with a slightly better quality wool and is found usually on the better mountain sheep walks.

The Scotch Black Face sheep as a permanent breeding type are confined to the Flintshire and Denbighshire borders. They appear to have established themselves in that limited area, and apart from the effect of the annual dispersal sales, which cause a widening of the area of their use for lamb production, they do not seem to spread over a wider region. Attempts made by farmers from the North of England to establish the breed on other mountain sheep-walks have met with little success. It is difficult to explain the failure, although a variety of reasons have been offered. One progressive sheep farmer in North Wales who was particularly keen on superseding the small native Welsh breed, tried successively Cheviots and Scotch Black Face. In both cases he failed to establish profitable flocks and he rather astounded the writer by explaining the failure of the Scotch Black Faced sheep as due to heavy driving rain which occurs there in the winter. However, to place a flock of sheep upon a strange sheep-walk is sure to court disaster for a time, as there is no doubt that knowledge of the walk and its sheltered places is a great asset to the flock in stormy weather. The importance of sheep being acquainted with the sheep-walk is economically emphasised in two ways, the most important of which is the acknowledgement of " acclimatisation value ", *i.e.*, an increased value per head of the flock which is native to the pasture; and also in admission of greater trouble and expense. Where shepherds are employed to tend several flocks belonging to different owners, they insist upon an extra charge per head if the sheep are strange to the walk. Thus the knowledge of the sheep-walk is a very important point in the maintenance of a flock upon the mountains.

This factor has given rise to a method of improving hill sheep by crossing instead of absolute replenishment. This crossing is influenced to a great extent by personal preferences, by the market demands, and also by the type and quality of grazing. Reference to the attempt to cross Welsh mountain ewes with a Cheviot ram prior to 1866 is made by H. M. Dixon.[4] On the farm of the Hon. Colonel Pennant, M.P., " and other improving proprietors in Caernarvonshire ", it appears that attempts were made with a view to increasing the size of the sheep. " This cross of Cheviot has increased the Welsh sheep from 40 lbs. dead weight to about 70 lbs. and has also doubled the wool on which the third cross seems to have no effect. Sheep of this cross were too heavy for the mountain and the trial of a cross-bred ram sent the size down again ". The result of this attempt also proved that the continued use of a Cheviot ram tended to make the carcase too fat and therefore it was not recognised as Welsh mutton. However, whilst the Cheviot-Welsh cross has not made any marked progress in North Wales it is fairly common in South Wales surrounding the district at present occupied by the Cheviot breed. The pure Cheviot blood is maintained by the annual importation of Cheviot rams from Scotland, these always being of the type required. Thus locally there is always an excellent supply of good quality rams for crossing with the Welsh mountain ewes. This cross seems to have given every satisfaction, being productive of a slightly larger type of lamb and a shade better quality wool. The market factor, however, appears to prevent any great progress as in that district there is general demand for a dark-faced or at least a speckled-faced lamb of either the Radnor or Kerry type. Breeders often state that they could secure a shilling or more per head over the price actually received if their stock possessed this characteristic. Further, although the wool is generally recognised to be of a shade better quality, very rarely does it secure a higher price than the typical Welsh wool. Local dealers tend to offer flat-rate prices for wool on neighbouring farms irrespective of some difference in quality. To overcome this difficulty one important breeder sells all his wool in Scotland. The ideal sheep aimed at by this cross is one slightly larger than the Welsh but not so large as the Cheviot. To maintain this type there does not appear to be any attempt to establish a permanent cross-breed, but the flocks are crossed by a Cheviot ram and then crossing back by a Welsh ram takes place to maintain the type. The ears are recognised as one of the main criteria. It is obvious that in this case we have local farmers crossing under the influence of the more progressive farmers who have introduced " foreign " stock.

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[4] Series II, Vol. II, *Journ. R.A.S.E.*, p. 370.

This raises an important point in agricultural progress which it is not intended to discuss here, but nevertheless its influence is very widespread. The dissemination of any new method in agriculture by practical demonstration, or as it may be termed " over the hedge ", is by far the most effective as farmers are always keen in observing the progress of their neighbours. Thus the influence of a progressive farmer in a districet cannot be over-estimated. There is, however, the possibility that a wealthy farmer may farm more for pleasure than for profit. Should a farmer of this type introduce " foreign " stock —and by his wealth be able to withstand losses which may be incurred—he may have an influence on local farmers which is not really progressive. Apart from indirect influence there is some tendency for the smaller farmers who want pure-bred rams to purchase them in the locality and they not infrequently buy lambs from such flocks. The influence of the home farm is waning and may be the Farm Institute is taking its place, but the industrialist who returns to the land should recognise the influence he may possess and estimate the possible effects of his farming on the community.

Another interesting cross, which has now been firmly established in the New Radnor Forest, is that of the Kerry ram and Welsh ewe. This is a typical sheep farming district, but it is in an area where the demand is for dark or speckled-faced sheep stock. As it is exposed country the generally established practice appears to be the purchase of Welsh mountain ewes of the hardiest type and these are crossed with Kerry rams. These mountain ewes are very rarely sold and are left on the mountain for breeding purposes until they die. The progeny is of the speckled type, having the typical Kerry markings. The ram lambs are castrated and sold as wether lambs. The ewe lambs may be sold, but a good many are retained and put to a Kerry ram. All the progeny of this second cross is sold as stores and breeding from the female stock of this second cross is very rare. Thus the market demand is satisfied and the climatic conditions are overcome by the replenishment of the foundation stock periodically by the purchase of hardy Welsh mountain ewes. The use of a second cross of this nature, although not widely adopted, is found in certain parts on hill land which is not recognised as good enough for the lowland type of sheep but too good to be used for the pure mountain breed.

Occasionally other types and crosses are to be found on hill land, but the breeds and crosses mentioned include all those of economic significance in the practice of sheep farming in recent years.

TYPES OF SHEEP IN THREE COUNTIES IN WALES.

By J. Glynne Williams, B.Sc., M.S.,
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Sheep husbandry in Wales is not an attempt in simple form to produce sheep which consist mainly of a greater proportion of the better joints of mutton and lamb. Flockmasters, whether on sheep farms or in mixed husbandry, have to attempt the selection of sheep for market production from the breeds which are available and which will thrive under the predominant natural conditions. An attempt is made to combine in what is produced what can be and what ought to be. While the lowland farmers have more freedom in choice of breeds and crosses as regards the conditions under which sheep will thrive, the types of sheep which they use are to some extent determined by the types which they are able to buy from the flockmasters who sell stores and ewes. While the lowland farmers do not maintain permanent breeding flocks of their own breeding and selection they are dependent on other farmers for their foundation stock. In recent years, fortunately, the demands from the consuming markets have turned in directions which favour the use of some of the small breeds as foundations for the crosses which are deemed necessary. But a great diversity of opinion exists with regard to the successful accomplishment of the use of breeds, or their combinations, in order to make the most of natural conditions and to meet market requirements, and at the present time a large number of varying breeds and crosses of sheep are to be seen in the lowland counties of Wales.

While the adjacent existence of hill and mountain breeds of sheep and of supplies of stores and breeding ewes, especially the native Welsh, exercises a predominant influence on the selection of ewes in two counties in North Wales, Denbigh and Flint, it appeared that there was a great deal of intermixture of breeds in Pembrokeshire. General observation leads to the recognition of use of different breeds and crosses but it does not provide accurate information on the numerical distribution and proportions of the different types. So an attempt was made to obtain figures for this distribution. By the courtesy of the Chief Constables of various counties, questions as to the breed or cross of sheep taken to the dipping baths were included in the form of return of sheep dipped in 1927. Returns were received from the Chief Constables of Denbigh, Flint, Pembroke, Cardigan, Brecon and Radnor, but in the first three cases it was possible to analyse the returns made in respect of individual flocks. The figures obtained are given below.

The figures do not refer to the whole of the sheep in each county, but to the ewes and rams returned on forms on which the breed statements for these classes were clear and distinct. The returns are sufficiently representative of the total flocks to be relied upon, except possibly as regards Pembrokeshire, where the native mountain breed does not appear to be sufficiently represented in the total. For the lowland areas of Pembrokeshire, however, the figures are fully representative. The breed or type was described by the farmer or by the inspector who witnessed the dipping, and as in some cases it was difficult to give an accurate description of the sheep, it was difficult to interpret the returns, especially as regards the nature of some of the crosses. In any case, some flocks of ewes of mixed breeding were really " beyond description " as to breed type. Absolute accuracy is not claimed for the figures, but they are fairly representative of the flocks.

Anglesey.

The following Table gives the total number of ewes and rams as returned on the sheep dipping forms for the county of Anglesey. A large number of ewes described as " cross-bred " have been carefully classified in the analysis, but owing to the large variety of crosses they have been grouped together for present purposes. Some forty fairly definite crosses, however, are represented.

Breeds of ewes and rams in the County of Anglesey.

(Data collected from the sheep dipping forms, 1927).

Breed.	*Ewes.*		*Rams.*
Welsh ...	55,362		4
Kerry ...	3,239		10
Lleyn ...	1,815		—
Wiltshire ...	1,224		297.
Southdown ...	965		40
Shropshire ...	709		8
Suffolk ...	531		2
Cheviot ...	221	Suffolk × Wilts ...	2
Scotch ...	221		—
Radnor ...	87		—
Dorset Horned ...	26		—
Welsh × Wilts ...	9,932		—
Crossbred ...	7,033		—
Local* ...	555		—
Total ...	81,833		358

* A large black-faced local sheep, locally regarded as a separate breed.

It is obvious that the Welsh mountain ewe holds the most important position amongst the breeding stock. Throughout the county fat lamb production is the most important branch of sheep farming and a comparison of the number of ewes with the number of rams shows that the most popular method is to cross the mountain ewe with a Down ram. The demand for Down rams has given rise to a subsidiary form of sheep husbandry, that of the production of ram lambs for crossing purposes. This to a large extent accounts for the number of breeding ewes of the larger Down types. Of the composite group designated " crossbred ", 1,869 were only so described in the returns. It is a fact worthy of note that of a total of 81,888 ewes only 1,869 were from a breed standpoint " beyond description ". It should be pointed out, however, that many were described as " Cross-Kerry " or " Cross-Southdown ", which it must be admitted is somewhat vague. Within this classification one group, that of the Welsh-Wiltshire cross, requires special mention. In general this class as a whole shows the importance of the system of lamb production from second and third cross ewes in the county. The practice of purchasing one-half or one-third of the breeding flock annually to replace those disposed of is quite common and has many advantages which will be discussed later.

The figures relating to rams bear out the general opinion held by many who are conversant with farming conditions in the county as to the importance of the Wiltshire ram for cross-breeding purposes. The county is unique in this respect, as in no other part of Wales is this cross (Wiltshire ram on Welsh mountain ewes) used so extensively. Reference to the more detailed figures shows that of the 297 rams recorded in the county forms, 270 were used for crossing with Welsh ewes. Amongst breeding ewes, Wiltshires hold a strong position, thus showing their importance from a ram breeding standpoint. It was not possible to differentiate in the figures between the Kerry Hill ewes purchased from the hills for fat lamb breeding purposes and the improved Kerry Hill sheep, rams of which breed are popular in some districts for fat lamb production. This mixing of unimproved and improved Kerry Hill sheep places the breed in an important position in the table of breeding ewes. The marked popularity of Wiltshires is referred to and partly explained in the " Reports of Experiments on the Production of Fat Lambs " (University College of North Wales, Bangor). In the general conclusion on Experiments 1901-1916 the report states : " The Wiltshire lambs are larger and in a favourable year fatten very readily. . . . They are quite hardy and actually the number of deaths among the lambs has been on an average less than with the Southdown cross ".

Flintshire

The returns for the county of Flint were in slightly different form, but the following Tables lay out the position as clearly as possible.

Breeds of ewes in Flintshire.

(Data collected from dipping forms, 1927).

	Ewes.	*Ewes and Lambs combined. (Other flocks).*
Welsh ...	22,519	11,996
Scotch ...	1,394	80
Kerry ...	1,263	133
Border Leicester ...	591	—
Cheviot ...	464	—
Suffolk ...	359	—
Southdown ...	288	275
Lleyn ...	176	—
Shropshire ...	136	137
Ryeland ...	16	—
Oxford ...	8	—
Cross-bred ...	20,319	5,064
Total ...	47,528	17,635

In addition to the above total number of ewes (col. 1), many returns were made showing only one number for total ewes and lambs of the flock. Thus it is impossible to state exactly how many are ewes and how many are lambs. In order to secure a little more accuracy these figures were kept separate from the others and are shown separately (col. 2).

In the above Table the most striking feature is the important position held by the Welsh mountain sheep. Thus the fact that the number of ewes in the county is not complete does not in any way interfere with the general conclusion that the Welsh mountain is the most important breeding ewe in the county. More than thirty crosses were enumerated.

The following Table shows the number of rams in the county as given by the sheep dipping returns. Comparing this Table with the similar Table for Anglesey, the small number of Wiltshire rams used in Flintshire is remarkable. It is obvious that the most popular ram in the county is the Southdown.

A reference to the more detailed figures shows that of the 277 Southdown rams shown, 169 were used for the production of fat lambs by crossing with Welsh ewes, whilst fifty-five were used in pure Southdown flocks, doubtless for the main purpose of producing rams for cross-breeding purposes. This latter type of sheep farming appears to be a normal development throughout the county. The rams for cross-breeding purposes are usually supplied locally, only the pedigree sheep breeder going further afield for rams to improve his flock. The report on sheep experiments previously quoted states that " taking North Wales as a

Breeds of rams in the County of Flint.

(Data collected from sheep dipping forms, 1927).

Breed.	*Number.*
Southdown ...	277
Border Leicester ...	84
Welsh ...	51
Suffolk ...	33
Shropshire ...	27
Ryeland ...	22
Kerry ...	9
Scotch ...	5
Wiltshire ...	4
Clun Forest ...	1
Cross-bred ...	45
Total ...	558

whole the Southdown is undoubtedly the most extensively used ". There is no doubt that it is widely distributed throughout Flintshire.

The Border Leicester rams which are second in importance in the county seem to be confined to special areas. Of the total given, six were used for crossing with Welsh ewes in the districts of Mold and Rhydymwyn, Coed Talon, Flint and Sealand; thirty-three were reported as being used in pedigree flocks, these again being solely in the districts of Mold and Rhydymwyn, Coed Talon, Flint, Northop and Sealand. In the same districts twelve Border Leicester rams were used on Scotch Black Faced sheep. It is difficult to explain the localised popularity of the cross, but it might be due to the fact that, compared with the Southdown, they give a larger lamb which stands well off the ground and is eminently suitable for overhead sale. Further, in poorer districts where it may not be possible to fatten the lambs, this cross gives excellent stock for autumn and winter feeding. The Shropshire ram, though not so important numerically as the other two, is found quite evenly distributed throughout the county except in the Rhuddlan district, where the Southdown appears to enjoy a monopoly. Whilst the above crosses appear to have established themselves and gained a fair distribution throughout the county, it is of interest to note that one farmer in the county, with a flock of 154 Cheviot ewes, had with them Ryeland, Southdown, Suffolk, Kerry and Shropshire rams. Such a variety of rams is rarely found on one farm, but doubtless it is an attempt to estimate by experiment the most profitable ram for use with Cheviot ewes.

Pembrokeshire.

Similar information for the county of Pembroke makes interesting comparison with the figures given above. As in the case of Flintshire, many of the returns gave only one figure for the ewes and lambs on the farm. Two separate Tables have been given, but this in no way affects the general conclusions. The most remarkable feature is the low position numerically of the Welsh mountain breed, but it is probable that a number of the mountain type appear under the description of " cross-bred " (see p. 118).

Breeds of ewes in the County of Pembroke.
(Data collected from sheep dipping forms, 1927).

Breed.	*Number.*	*Ewes and Lambs combined. (Other flocks).*
Shropshire ...	5,150	3,272
Kerry ...	1,630	375
Suffolk ...	1,543	855
Ryeland ...	773	788
Mountain (Welsh) ...	767	—
Hampshire ...	713	78
Welsh ...	233	—
Southdown ...	192	269
Cheviot ...	159	54
Leicester ...	15	—
Oxford ...	2	—
Cross-bred ...	20,905	28,468
Total ...	32,082	34,154

It is obvious that the importation of mountain ewes for the purpose of fat lamb production is not carried on to any appreciable extent. This fact is further emphasised by the large number of cross-bred ewes. Of 32,082 returned in the county a very large number were " beyond breed description ".

The crossing of the ewes with Down rams for fat lamb production is the general system of sheep farming in the lowland districts, but the breeding stock is maintained by introducing to the flock the ewe lambs, particularly the twins. Very rarely will the farmer retain the same breed of ram for several years, as this merely tends to bring his sheep farming to pure breeding. Thus he changes his breed of ram periodically and it is not many years before the ewes which form his breeding flock show traces of variety of breeds and can only be described as cross-breds or, more crudely, as " mongrels ".

The Table showing the number of rams returned differs mainly from the returns of the other two counties in the total absence of Wiltshires and the low position of the Southdowns

Number of rams in Pembrokeshire.

Breed.		*Number.*
Ryeland	...	115
Shropshire	...	109
Kerry	...	53
Suffolk	...	27
Hampshire	...	19
Mountain	...	16
Leicester	...	5
Southdown	...	2
Welsh	...	2
Cross-bred	...	188
Total	...	536

and Leicesters. Again in this Table the number of cross-breds figures prominently and therefore does not tend to show Pembrokeshire sheep farming in a favourable light.

It is difficult, if not impossible, to account for all the variations in the breeds and crosses used. They cannot all be used in the well-informed and careful pursuit of the economical or profitable flock in relation to the conditions on the farms and in the markets. " Fashion " plays a part in the changes in use of rams from year to year. Personal preference or " fancy " also plays a part in choice. Imitation is important in many cases, for one influential man who buys a Kerry, for instance, instead of a Shropshire in a well considered mating with his ewes may be imitated by a neighbour who has a flock of different type. The failure to sell all cross-bred ewe lambs, bred primarily for the fat lamb trade, also plays a part in mongrelising the flocks. There is insufficient clearance of stock and replenishment by purchase from the store-raising areas where straight-bred ewes are available. Farmers' actual and definite knowledge of the results of various crosses is insufficient to enable them to plan a rational policy and pursue it with confidence. Moreover, butchers and lamb-buyers in some districts have changed their opinions—as some farmers say, have " chopped and changed " from time to time.

The lowland farmer who has been breeding for the fat lamb market during recent years has had a very difficult task and apparently little guidance. It would appear to be quite possible for those who are interested in lamb production to obtain valuable information by controlled tests organised locally, or to obtain and apply in their own circumstances information obtained from tests elsewhere.

NATIONALITY TRIALS WITH COCKSFOOT AND OBSERVATIONS ON THE GENERAL BEARING OF THE RELATIONSHIP OF STEM SHOOTS TO LEAF SHOOTS.

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The main trial (B. 84) here reported upon was sown on the Penglais Field during 1921, and owing to the weather conditions it was not possible to sow until August 24th, a date which subsequent experiments at the Station have shown to be much too late for the successful establishment of cocksfoot.[1] The trial was not, therefore, a fair test of the different nationalities and strains brought under review and the more so since it has subsequently been shown that when the germinations and grain weights are low, establishment of viable seed is much less satisfactory than when these are high. The average germination of the New Zealand seed was 98 per cent., of the Danish 90 per cent., and of the French 88 per cent., while that of the indigenous was only 55 per cent. Thus the indigenous was set at a great initial disadvantage from the point of view of establishment.[2]

The trial included one lot of New Zealand seed, one lot of French, one lot of Danish and five lots of indigenous.[3] The New Zealand, French and Danish were set out in quadruplicated rod plots and each lot of indigenous in duplicate rod plots for each method of sowing.

The trial consisted of broadcast plots, drill (drills 12 inches apart) plots, and plots sown with the different cocksfoot nationalities and strains, each mixed with Essex late-flowering red clover.

Data were obtained over a period of four harvest years, and the results, although not to be regarded as entirely typical because of the poor relative establishment of the indigenous lots, are none the less worthy of brief mention, and the present article must be regarded as preliminary to a more detailed report covering a large number of trials still in progress.

Discussion of results: yield data.

A synopsis of the yield data is presented in Table I.

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[1] See Stapledon, Davies and Beddows (4).

[2] Despite the fact that the seed rates were adjusted in conformity with the germinations.

[3] These lots represented preliminary collections and had not been subjected to any mass selection or breeding.

TABLE I.

To show hay yields for the four harvest years for the average of the four nationalities separately in lb. green weight per rod plot. *Note.*—The yields for the first two harvest years include weeds with cocksfoot; for the third and fourth harvest years the yields are for cocksfoot only. The mixture yields include red clover, but only in negligible amount after the second harvest year.

Nationality.	*Year.*	*Broadcast.*		*Drills.*		*Average of broadcast and drill plots.*	*Mixture. Cocksfoot with late flowering red clover.*	
		Hay.	*Aftermath.*	*Hay.*	*Aftermath.*	*Hay.*	*Hay.*	*Aftermath.*
New Zealand	1922	64.5	—	49.2	—	56.8	89.7	—
	1923	57.9	29.5	53.1	20.2	55.5	92.4	46.4
	1924	47.2	—	48.1	—	47.6	54.4	—
	1925	19.3	—	18.1	—	18.7	30.6	—
Total for 4 harvest years		188.9	—	168.5	—	178.6	267.1	—
Indigenous	1922	36.9	—	37.4	—	37.1	68.0	—
	1923	60.3	24.8	60.9	21.3	60.6	88.0	38.0
	1924	43.0	—	46.6	—	44.8	51.8	—
	1925	14.8	—	19.0	—	16.9	23.3	—
Total for 4 harvest years		155.0	—	163.9	—	159.4	231.1	—
Danish	1922	60.5	—	48.5	—	54.5	94.5	—
	1923	66.2	17.2	56.2	14.1	61.2	87.6	28.4
	1924	43.6	—	38.4	—	41.0	44.0	—
	1925	9.5	—	7.0	—	8.2	18.1	
Total for 4 harvest years		179.8	—	150.1	—	164.9	244.2	—
French	1922	51.5	—	32.5	—	41.8	70.0	—
	1923	58.2	12.0	51.5	9.2	54.8	102.0	21.7
	1924	21.3	—	10.1	—	15.7	23.4	—
	1925	4.8	—	1.4	—	3.1	3.2	—
Total for 4 harvest years		135.8	—	95.5	—	115.4	198.6	—

On the average of all nationalities and strains the broadcast plots yielded more heavily than the drill plots, the only individual exception being the indigenous lots, which gave their highest yields in the drill plots. During the seeding year it was quite obvious that the indigenous strains had made their best establishment on the drill plots.

The yield data are interesting as showing that despite poor initial establishment the indigenous strains were outyielding the Danish and French by the third harvest year (average of broadcast and drills) and by the fourth harvest year were giving twice as heavy yields as the Danish and over four times as heavy yields as the French. The poor yielding ability of the French cocksfoot is in complete confirmation of the earlier (garden) trials (1), as is the excellent result from the New Zealand strain. In the case of the latter strain the viability of the seed was good and the establishment quite as satisfactory as the Danish, so that the comparison is a fair one, and we find the New Zealand strain yielding practically as heavily as the Danish in the first and second harvest years and outyielding it by a good margin in the third and fourth years. A comparison of the aftermath data serves further to emphasise, as previous garden trials have emphasised, the close relationship between the New Zealand and indigenous strains, for in the second harvest year (when aftermath weights were taken) the yields have been very similar for the indigenous and New Zealand lots and vastly superior to the Danish and French. Aftermath results in the same general direction have been obtained from another experiment (B. 101) in the second harvest year, when the yields in lb. green fodder per one-hundredth acre plots were as under :—

Danish 22; New Zealand 29; Indigenous 28.

Taking the data as a whole and regarding New Zealand and indigenous as one unit and Danish and French as another we see that the outstanding advantage of the first unit is its ability to yield better than the second in the third and fourth harvest years and in its greater capacity for aftermath production, while the contrast between New Zealand and Danish (under about equal chances of establishment) show that the first unit falls but little short of the second in regard to hay production in the first and second harvest years.

The plots sown with late-flowering red clover confirm the results from the broadcast and drill plots and again show the New Zealand-indigenous unit considerably superior to the Danish-French unit in yielding capacity in the third and fourth harvest years and in the matter of aftermath production.

These mixture plots are interesting in another connection. The red clover had ceased to contribute in any appreciable amount to the hay in the third and fourth harvest years, and yet in these latter years the yield of the mixture (exclusive of weeds and therefore almost wholly cocksfoot) was greater in every case than on either the drill or broadcast pure cocksfoot plots (yield given wholly as cocksfoot) thus suggesting that the red clover " root " had left an inheritance of soil fertility from the first and second years which reacted on the development of cocksfoot in the third and fourth years.[4]

Ratio stem shoots: leaf shoots.

The produce harvested in the third and fourth harvest years was separated into panicle-bearing shoots and non-panicle-bearing shoots,[5] a procedure which gives a rough measure of the relative leafiness of the different strains. The results of these analyses from both the broadcast pure plots and the mixture plots are given in Table II. The two sets of plots are in agreement in so far as the general trend of behaviour of strains is concerned.

Again we see the marked general similarity between the New Zealand and indigenous on the one hand and Danish and French on the other. Taking the broadcast pure plots the New Zealand-indigenous unit gave a leaf shoot contribution of 65.2 per cent. (average of both harvest years) while the Danish-French unit gave a leaf shoot contribution of only 46.5 per cent., thus showing—as garden trials have already abundantly demonstrated—the much greater leafiness of the former unit. It follows, therefore, from the nearness of the yields of the New Zealand-indigenous unit to those of the Danish-French unit that even in the first and second harvest years, in the matter of all-important leaf production the advantage would be decidedly in favour of the former unit.

The ratio of panicle-bearing shoots to non-panicle-bearing shoots (which is a rough measure of the ratio stem-shoots to leaf-shoots) in relation to the behaviour of species and strains as to hay yield under different conditions of fertility is an important one and may be usefully considered here. It has been noted in connection with ecotypical studies on cocksfoot (single plants)[6] that in the case of the Danish and French types barren shoots are not produced to any considerable extent until the panicle shoots

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[4] This result should be compared to results of a somewhat similar nature discussed in a previous bulletin. (See Stapledon and Davies (3).)

[5] The majority of the non-panicle-bearing shoots were leaf shoots—a small proportion were, however, stem shoots.

[6] See Stapledon (2).

TABLE II.

To show (1) percentage of bent and weeds in the broadcast pure plots; (2) of bent and weeds in the mixture plots; (3) percentage of panicle shoots and of non-panicle shoots of cocksfoot in both broadcast pure plots and in the mixture plots. Data from third and fourth harvest years.

Nationality.		*Broadcast pure plots. Per cent.*					*Mixture plots. Per cent.*				
		Bent	*Weeds*	*Bent and Weeds*	*Panicle shoots of cocksfoot.*	*Leaf* shoots of cocksfoot.*	*Bent*	*Weeds*	*Bent and Weeds*	*Panicle shoots of cocksfoot.*	*Leaf* shoots of cocksfoot.*
New Zealand	**1924**	30.0	17.3	47.3	36.6	63.4	23.4	9.7	33.1	45.2	54.8
	1925	37.4	30.0	67.4	26.0	74.0	31.8	24.7	56.5	36.3	63.7
Indigenous	**1924**	20.9	18.8	39.7	39.3	60.7	18.0	9.3	27.3	44.5	55.5
	1925	37.6	39.7	77.3	37.1	62.9	35.7	21.5	57.2	51.6	48.4
Danish	**1924**	30.0	17.5	47.5	59.6	40.4	23.4	9.8	33.2	71.1	28.9
	1925	39.7	44.9	84.6	50.3	49.7	42.2	24.5	66.7	65.9	34.1
French	**1924**	14.3	61.4	75.7	47.9	52.1	30.1	24.0	54.1	60.2	39.8
	1925	20.3	71.9	92.2	56.0	44.0	41.2	49.9	91.1	68.8	31.2

* Leaf-shoots together with a small proportion of non-panicle bearing stem-shoots.

have fully developed and are in full flower—while in the case of the denser indigenous types the development of panicle shoots and leaf shoots is to a very considerable extent contemporaneous. Under unfavourable conditions (*e.g.*, periods of drought or marked soil infertility) experiments now in progress are, however, showing that there is a decided tendency especially in the denser (indigenous) types for the production of panicle-bearing shoots to be reduced below the normal and (or) for the panicle-bearing shoots to be unusually short and small, and this if pronounced tends in the direction of reduced hay yields. Critical manurial experiments, upon which a detailed report is in preparation, have, moreover, shown that the indigenous (dense) strains of cocksfoot react to high manuring (nitrogen, potash and phosphates) more sumptuously than do the Danish (lax) strains, and that this is chiefly due to a greater relative increase in the size and (or) number of the panicle-bearing shoots of the indigenous than of the Danish. Under conditions of low fertility the indigenous strains produce too few and (or) too small panicle shoots to be capable of high hay yields—and thus it is, in the first and second harvest years (when the Danish types are still vigorous and capable of abundant panicle production), that these types tend to outyield the indigenous; and the less favourable the conditions (especially in the first harvest year) the greater is the advantage in favour of the foreign types. In later harvest years the extra persistency of the indigenous and the greater loss of vigour of the foreign (seen in a reduction in the size of panicle shoots) counter-balances the earlier advantage of the latter strains (judged merely in terms of weight) and the indigenous strains as well as being the most leafy become also the highest (hay) yielding. In extreme cases under conditions of marked infertility the panicle shoots of the densest indigenous types may be so small and light that even in the third harvest year, despite marked thinning out of the Danish types, these latter may none the less yield the heaviest hay crop—a crop, however, with a very low percentage of leaf. Such has, however, only been the case in one of the numerous trials conducted at the Station—a trial (B. 101 Brick Field) conducted on a field with a very thin and infertile soil, particularly sensitive to drought.

The relation of the ratio stem shoot : leaf shoot to hay yield under conditions of infertility is well shown by the figures given in Table III for a number of species tested in the trial (B. 101) above referred to.

It will be seen from the figures that it has been the species with the highest percentage of stem-shoots, *e.g.*, timothy, perennial rye-grass, golden oat grass and Chewing's fescue which have given the heaviest hay crops, all these species having surpassed cocksfoot, meadow fescue and meadow foxtail (with high percentages of leaf shoots) in yield.[7]

TABLE III.

To show (1) the yield of hay as green fodder in lb. per 1/100 acre in the second harvest year (1924) for a number of species of grasses in relation to (2) the ratio panicle and stem shoots to leaf shoots: a field of low fertility: B. 101.

Species and number of lots averaged.		*Yield of hay.*	*Percentage.*	
			Stem shoots.	*Leaf shoots.*
Perennial rye-grass:	8	91.1	100	0
Italian rye-grass:	5	55.4	95	5
Cocksfoot:	7	83.5	64	36
Meadow fescue:	2	86.3	73	27
Timothy:	11	106.8	98*	2
Meadow foxtail:	2	74.4	32	68
Golden oat grass:	1	90.7	97	3
Chewing's fescue:	1	89.4	96	4

* In the case of timothy about one-third of the stem-shoots were non-panicle-bearing; in the case of the other species practically all stem-shoots were panicle-bearing.

In the case of these three latter species, moreover, the strains with the highest stem-shoot : leaf-shoot ratio have given the heaviest hay crop as is indicated by the figures in Table IV.

TABLE IV.

To show (1) the yield of hay as green fodder in lb. per 1/100 acre in the second harvest year (1924) for different strains of three species of grass in relation to (2) the ratio panicle and stem shoots to leaf shoots: a field of low fertility: B. 101.

Species and nationality.	*Yield of hay.*	*Percentage.*	
		Stem shoots.	*Leaf shoots.*
Cocksfoot:			
Indigenous and New Zealand ...	66	53	47
Danish ...	107	78	22
Meadow fescue:			
Swedish pedigree ...	74	65	35
Danish commercial ...	99	80	20
Meadow foxtail:			
Indigenous ...	69	14	86
Danish commercial ...	79	50	50

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[7] It is interesting to compare these yields with those obtained in the gardens (B. 139) under conditions of high fertility, where in the second harvest year, despite a stem-shoot : leaf-shoot ratio strongly in favour of leaf-shoots, the indigenous cocksfoot and indigenous meadow fescue proved themselves to be the highest yielding strains, outyielding not only their non-indigenous counterparts but all other species, with the sole exception of tall fescue.

It would seem therefore to follow from the results under discussion that heavy crops of hay can only be produced if a certain ratio stem-shoots : leaf-shoots is attained to; and these data tend to show how it comes about that grasses like cocksfoot, meadow fescue and meadow foxtail can only produce heavy hay crops under conditions of high fertility, while perennial rye-grass, golden oat grass and Chewing's fescue can attain more nearly to their average crops under less favourable conditions. The more leafy strains of a particular species would also appear to require higher fertility than the less leafy in order to yield reasonably heavy hay crops. This is further indicated by the figures in Table I, from which it will be seen that the average of the indigenous and New Zealand cocksfoot in the third and fourth harvest years under the influence of clover residues has increased more than has the Danish cocksfoot under a similar influence. The chief practical lesson to be learned from the data under discussion is that it is even more important to apply liberal dressings of fertilizers (including nitrogenous dressings) to swards largely consisting of the indigenous leafy strains than to those consisting of the more stemmy non-indigenous strains in order to ensure the production of heavy hay crops, and especially is this necessary if it is desired to obtain as heavy yields from the latter strains as from the former in the first two harvest years.

Similarly since panicle production is at stake it would seem more than probable that heavy manurial dressings would be necessary to ensure good seed crops from the indigenous strains of such grasses as cocksfoot, meadow fescue and meadow foxtail in particular, and the trials so far conducted at the Station relative to seed production are in confirmation of this view.

Ability to suppress weeds.

The contribution of bent grass and weeds to the hay in the third and fourth harvest years is also shown in Table II. These data again indicate the similarity between the New Zealand and indigenous strains, for it is these strains which have exercised the greater retarding influence on weeds—it is these strains, that is to say, which have shown the greatest persistency into the third and fourth harvest years. The very poor persistency of the French cocksfoot is demonstrated by the excessive weediness of the plots sown with this strain in the fourth harvest year.

Early spring growth.

During the earlier harvest years while the French and Danish plots are still vigorous they grow much more quickly early in the spring than do the indigenous and New Zealand. This was well shown by measurements taken to the ligule of the uppermost leaf on April 10th of the first harvest year (1922). The results are as follows in cm. :

French.	*Danish.*	*New Zealand.*	*Indigenous.*
15.5	14.0	9.0	7.4

and are confirmed by readings taken on April 23rd in the first harvest year (1923) in the case of trial B. 101 (Brick Field).

Danish.	*New Zealand.*	*Indigenous.*
16	10	8

These results are again in complete confirmation of single plant data from the gardens and show that the French strains are the first and the indigenous (in the aggregate) the last to start active growth in the spring.

Winter burning.

Cocksfoot burns or browns off rather earlier than most other species. The strains, however, show marked differences in this respect. Burn was estimated (on a scale of marks 10 = most burn) on all the plots throughout the duration of the experiment. The figures hereunder are typical and are representative of the differential behaviour of the nationalities.

Burn on a scale of marks (10 = most burn).

	December 15, 1921.	*April 10, 1923.*
New Zealand ...	1.5	3.3
Indigenous ...	2.1	3.0
Danish ...	6.8	1.5
French ...	7.0	1.1

Results of a similar nature were recorded from B.101 on December 12th, 1923, *e.g.*, Danish 10 and indigenous 4.

The data show that in the winter months New Zealand cocksfoot remains greener than any other strain (and this has been confirmed by subsequent trials), the indigenous strains are nearly as winter green as the New Zealand, and these two nationalities are altogether more winter green than the ordinary commercial Danish and French. When growth starts in the spring the amount of winter burn becomes most rapidly masked in those strains which make the earliest growth. Consequently return to greenness is most rapid in the French and Danish strains and longer delayed in the indigenous and New Zealand.

Summary.

This is the first report from the Station in which indigenous, New Zealand, Danish and French cocksfoot have been compared over four harvest years under field conditions.

New Zealand and indigenous strains are closely allied and are very different from Danish and French. The former strains tend to outyield the latter in the third and fourth harvest years—they are decidedly the most persistent. In the first and second harvest years the Danish and French strains are prone to yield as or more heavily than the New Zealand and indigenous. In aftermath production the advantage is wholly and at all times with the New Zealand and indigenous strains.

The Danish and French cocksfoot start growth earlier in the spring than the indigenous and New Zealand—the latter are, however, very decidedly more winter green than the former and maintain a less weedy sward as the years advance.

The New Zealand and indigenous strains give rise to a herbage with a leaf-shoot : stem-shoot ratio more heavily biased in favour of leaf shoots than do the Danish and French strains.

Both species *qua* species and the strains of particular species which tend to have the higher leaf-shoot : stem-shoot ratio are prone in the earlier harvest years to yield lighter hay crops than those species or strains with a ratio more in favour of stem-shoots.

Under conditions of infertility this tends to be more pronounced than under conditions of fertility. Under high manuring there is evidence to suggest that those species and strains biased in favour of leaf-shoots make the heaviest relative response in the hay crop.

Under all conditions the leaf contribution to the hay is higher in the strains with leaf-shoots predominating than in those with stem-shoots predominating.

Acknowledgements.

The author's thanks are abundantly due to Captain R. D. Williams, M.Sc., who was in charge of experiment B. 101 in the earlier years, and to Mr. William Davies, M.Sc., who was largely in charge of this experiment and B. 84 during the later harvest years.

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PERENNIAL RYE-GRASS AT ABERYSTWYTH.

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I. Introduction.

Preliminary trials with " nationalities " of Perennial Rye-grass were carried out at the Welsh Plant Breeding Station at Aberystwyth in the seasons 1919-21, and the results were included in the first " herbage " bulletin of the Station (8). As this bulletin is now out of print, the essential findings, omitting only unimportant details, may be reprinted here as an introduction to a general survey of the present position.

" *Indigenous.* In the drills gave rise to an extremely dense turf of relatively short glossy leaves in the early part of the year. On the whole they did not appear to be appreciably later in flowering than the ordinary commercial.[1] The relatively low proportion of flowering stems to leaf was at this time, however, very marked and this became even more pronounced as the plants approached maturity. These features are indicated [in tables][2] by the proportion of barren tillers and the proportion of leaf in the hay, but on the ground the difference appeared even greater than would be expected from these figures.

" *Commercial English, Irish and Ayrshire and Pedigree Ayrshire.* Growth in these appeared to be more lax and the leaves longer than in the indigenous, while at flowering time the proportion of stem to leaf was much greater, and towards maturity there was a greater tendency to withering of basal leaves. This last feature is probably directly connected with the much lower proportion of barren tillers. In the aftermath also, these lots ran into inflorescence much more readily than the indigenous.

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[1] It should be pointed out that in this particular case " indigenous " included both seeds derived from wild white clover cleanings (and therefore from old English pastures) and seed collected locally from positions which were " old " but not really comparable with good old English pastures. This undoubtedly explains why no marked difference in time of flowering was found as compared with commercial.

[2] The tables are not here reproduced.

" *Danish Pedigree.* Two lots of Danish Pedigree Perennials were included, both bearing the same name, but the seed was obtained from different sources. One of these lots, Ba 84, differed relatively little from the above [commercial] group, but the other, Ba 52, made exceedingly lax spring growth, and the flowering stems produced later bore very few leaves and were wiry in appearance. The leaves were also unusually short in proportion to breadth at base.

" *Svalöf Victoria.* In the early part of the season this was less attractive than many others. Its growth was slow, and even up to the middle of March it remained badly " burned ", suffering apparently much more from climatic conditions than the others. With warmer weather it flourished exceedingly, growth was dense and throughout most of the season it remained much darker green than others. It came into flower decidedly later than other Perennials, and the number of inflorescences produced in the aftermath was relatively low.

. . . . . .

" The productivity characteristics of lots . . . included in the field trials . . . may briefly be summed up as follows :—

" *Indigenous.* Poor in seeding year but yielding a heavy crop of hay, containing a high proportion of leaf to stem and a relatively good aftermath in the first harvest year.

" *Ayrshire Pedigree.* Far superior to the indigenous in the seeding year, but inferior to English commercial; slightly inferior to indigenous in hay production, but superior to all others; aftermath production very low.

" *Ayrshire Commercial.* About equal to Ayrshire Pedigree in stubble cut, much inferior to the latter in hay production, but somewhat better in aftermath.

" *Irish.* Moderate in stubble cut and in hay production, but better than all others except indigenous and Svalöf Victoria in aftermath.

" *English.* Gave the heaviest stubble cut and the lightest aftermath, and but a very moderate hay crop.

" *Svalöf Victoria.* Not much superior to indigenous in stubble cut; gave a relatively poor hay crop but equalled the best in aftermath.

> " In the continuous pasture cuts in the gardens . . . the three outstanding nationalities were Ayrshire Pedigree, Svalöf Victoria and Irish, with Indigenous, English and Ayrshire Commercial well behind, and Danish [Pedigree] particularly poor.
>
> " . . . Maximum spring growth was somewhat later in indigenous, Svalöf Victoria and commercial Ayrshire than in the others, but no very marked difference in respect of distribution of growth throughout the season is shown and [the results] would suggest little difference in persistency except perhaps in the case of Danish, where there was a sudden drop in the last [growth] period.
>
> . . . .
>
> " Observation, however, showed that at the close of the season the difference in persistency was quite marked, especially as between indigenous and non-indigenous. The ' pasture ' drills of the indigenous maintained a close and regular turf, while in most of the non-indigenous, growth on the drills was thin and irregular. Danish probably showed lack of persistency to a greater extent than any of the others, but there did not appear to be nearly the same difference amongst the non-indigenous themselves as there was between these and the indigenous ".

II. Further lines of work.

The general conclusions quoted above, together with the data and general observations upon which they were based, suggested two things :—

(1) The main contrast was found between the indigenous on the one hand and the non-indigenous on the other. The latter group consisted mainly of British-grown Commercial, and since this forms the bulk of the seed on the market, the most profitable line of further comparison would be between British Indigenous and British Commercial.

(2) The great variation in type and in vigour even within pedigree strains, and particularly amongst the single plants of non-pedigree lots, showed that for the selection of plants for breeding purposes, lots must be studied not in bulk but as single plants.

III. Yield studies with bulk lots.

With the work under the first heading I have not been intimately connected except to a relatively small extent, but published results show that :—

(*a*) When indigenous and non-indigenous were compared under pasture and under hay conditions over two harvest years the former outyielded the latter by 18 per cent. (6);

(*b*) The indigenous plots at the end of the second harvest year showed an excess tiller population as compared with non-indigenous of over 50 per cent. (6);

(*c*) The conclusion drawn by Stapledon and Davies (10) from results obtained from a comparison of commercial and indigenous as constituents of seeds mixtures may be quoted. " The indigenous strain of perennial rye-grass outyielded the commercial in each harvest year and also contributed in higher degree to the total hay crop. The result was most marked in the fourth harvest year when the indigenous gave nearly double the yield of the commercial and contributed nearly twice as abundantly to the total hay yields ".

To these results may now be added a brief summary of the results obtained in Experiment B. 165. The main purpose of this experiment was to obtain a preliminary test of a new pasture strain of Perennial Rye-grass bred at the Station. When the experiment was started, very little seed of this strain, 1412, was available, and therefore actual field trials were not possible. As the next best thing, small pure plots were laid out in the Gardens on a very poor piece of ground. Each plot measured 10 feet x 5 feet, so that it was possible at each end of each plot to obtain a square yard for cutting purposes and still leave a margin so that the weight of cut herbage would not be influenced by " marginal effects ".

The plots were laid down in 1926, but no data were taken in that year beyond what could be gathered from observation alone. The first weight determinations were made in April, 1927, when a square yard at one end of each plot was cut for " pasture " purposes. The area was marked off by means of a mesh which has been used throughout the experiment. In 1927, the " pasture " areas were cut and the herbage weighed, at intervals of about six weeks.

" Hay " cuts on a square yard at the other end of each plot were made. The date of cutting for hay varied from June 14th in the case of the earliest (Danish) to July 9th in the case of the latest lots. In this season a single aftermath cut was taken uniformly on September 23rd.

Procedure in 1928 was on similar lines except that the areas in each plot were reversed, the " hay " area of 1927 being now used as " pasture " and *vice versa*. A preliminary cut was now also taken from the " hay " areas in April, while " pasture " cuts were made at monthly intervals.

In 1929 procedure was the same as in 1928 except that the " pasture " intervals were again extended to six weeks.

The lots included in the trial are shown in Table I. Each lot was represented by three beds, so that the results actually represent for each lot three " hay " and three " pasture " areas for each year.

TABLE I.

Relative green weight yields of perennial rye-grass in experiment B. 165.

Station number.	*Origin.*	*Relative weights.*								
		Hay.				*Pasture.*				
		1927	*1928*	*1929*	*Total*	*1927*	*1928*	*1929*	*Total*	*Grand total.*
1412	Station-bred pasture ...	159	157	180	163	144	121	205	148	156
1751	Hawke's Bay (N.Z.) ...	174	142	148	159	108	102	103	105	133
1740	British Indigenous ...	132	98	103	116	126	111	137	124	120
1353	Jædersk (Norwegian) ...	108	106	151	118	78	92	163	97	109
1739	British Commercial ...	100	100	100	100	100	100	100	100	100
1744	Svalöf Victoria ...	98	104	79	95	96	90	92	94	94
1413	Once-grown Indigenous	91	80	85	87	77	63	69	71	79
1784	Danish Lundbäk ...	75	—	—	—	—	109	—	—	—

It cannot be asserted that the results represent absolute values. The number of plots was small and the areas were very small. At the same time, judging from observations, they undoubtedly give a fair representation of the relative values of the different lots.

No further notice will be taken of the Station-bred Pedigree Strain 1412, as it is not here intended to discuss such strains. The figures for each lot in the table represent weight in relation to British Commercial at 100, and some interesting results are thus obtained. The New Zealand (Hawke's Bay) lot has done remarkably well under hay conditons, but under pasture conditions it has proved to be decidedly inferior to British Indigenous. On the whole, the Norwegian " Jædersk " has done well after a bad start,[3] but it has only outstripped the British Commercial to any serious extent in the third harvest year. In this season it was ahead even of Hawke's Bay and British Indigenous.

Svalöf Victoria has done relatively badly, not even reaching the level of British Commercial, but its yield has been consistent throughout the period. " Once-grown " indigenous made a very poor show, while Danish " Lundbäk " bulked up tremendously and gave the highest yield of all lots in the hay cut of the first harvest year. This lot, however, failed almost completely after the June cuts (both hay and pasture areas) of that first year, and there were no further cuts.

In Experiment B. 139 a few other lots have been studied under somewhat similar conditions to those of B. 165. Three particularly interesting lots, " Wimmera Rye-grass " (two lots), and " Argentine Rye-grass " were included in this experiment, and the results obtained in relation to British Commercial as the standard are shown in Table II.[4]

TABLE II.

Hay and pasture results with four lots in experiment B. 139.

Origin.	*Relative yields.*			
	Seeding year.		*First harvest year.*	*Second harvest year.*
	Oct. cut.	*Hay.*	*Pasture.*	*Hay.*
British Commercial	100	100	100	100
Argentine rye-grass	109	64	52	84
Wimmera rye-grass	144	50	48	80

The seed of " Argentine Rye-grass " was an excellent sample and gave a rapid and successful establishment in the plots, so that its yield in October of the seeding year somewhat exceeded that of British Commercial. In characteristics, however, it proved to be of the rapid-growing, short-lived type, and, as the figures in Table II show, it gave very poor results in the first harvest year. By October of that year very few plants were alive and these died out in the second harvest year.

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[3] Jædersk suffered badly from rust in the autumn of the seeding year.

[4] I am indebted to the Director of the Station, Professor R. G. Stapledon, M.A., for details of this experiment and the results obtained.

One of the " Wimmera " Rye-grass lots was described specifically as " *Lolium subulatum* ", but in behaviour the two lots were exactly alike, so that the results are not given separately. In the seeding year they made growth even more rapidly than the Argentine Rye-grass, but even in the October cut of that year the produce was very stemmy. The great majority of the plants then died out, and the produce in the second harvest year was very stemmy. After this year, the plots were bare except for volunteer grasses and weeds.

IV. Single-plant studies.

Single-plant studies have been more extensive, particularly in respect of some of the " nationalities " referred to above. The main reason for this is that a far greater number of lots can be studied than would be possible under any kind of field or garden plot conditions. Moreover, recent work with Perennial Rye-grass has been mainly in the direction of the selection of single plants with a view to their use as parents.

The method of study adopted has been very largely that of observation, but in a relatively small number of cases actual productivity data have been collected, more particularly where extra-Station lots have been used for purposes of comparison with Station-bred families or strains. The two methods have their particular advantages and, in fact, where performance is of great importance, as in the case of Station-bred lots, they are used side by side so that a lot may be judged by both standards. Actually, the results have shown that to a great extent the characteristics of a lot both as regards yield and type of herbage produced can be gauged with a considerable degree of accuracy from observation alone, but actual weight results are more tangible and definite. On the other hand, when plants are constantly cut back, something is necessarily lost and more particularly data concerning growth habit and general appearance, and when the selection of plants for use as parents is the main point at issue this is of great importance. From this point of view, the additional tangibility of the performance results is not a sufficient recompense for the observation data which are lost. Moreover, actual weight results cannot be considered to be the most important where parent plants are concerned, since it does not necessarily follow that because plant " A " has given better results than plant " B " the progeny of " A " × " C " is better than that of " B " × " C ". That is to say, the real test of a parent plant is not its own performance but that of its progeny. Thus the observation method is justified in so far as the first selection of parent plants is concerned, but in order that they may be fully compared, both observation and performance data must be resorted to in the case of their progeny.

When a large population of single plants of Perennial Rye-grass from many different sources of origin is made, one of its most striking characteristics is the degree of variability within any one lot of whatever origin, and, studied as a whole, such an aggregate of plants defies detailed classification. Extreme types might be fixed upon, but whatever characteristic be taken, every gradation from the one extreme to the other can generally be found. This fact is in contrast with that found by Stapledon in the case of Cocksfoot (*Dactylis glomerata*) where it was possible to classify the material into types and sub-types in such a way that certain definite ecotypes were identified (7).

Quite recently, Levy and Davies (5) have attempted to define the morphological and other characteristics by means of which what they term " true perennial " and " pseudo or false perennial " may be distinguished. Not one of the characteristics they mention is of definite value as far as the types met with at Aberystwyth are concerned, and the authors themselves admit that " the real test of the true as against the pseudo or false is that of longevity or persistency ".

Gregor and Sansome (3) have found that to some extent at least wild Perennial Rye-grass from certain positions tends to form an ecotype which, however, is not a true genotype, since plants from the same habitat have given rise to progeny definitely different from themselves, while plants from other positions were themselves not of a uniform type.

This tendency towards an ecotype I have found to be of the greatest value for purposes of classification. Even though in a general population from all possible sources of origin the plants give a range of individual types which defies detailed classification, and each lot varies greatly from plant to plant, each lot appears to have an aggregate character of its own. For instance, when two lots, one of British Commercial and one of British Indigenous are grown side by side (as spaced single plants) in spite of the wide variation within each lot the contrast between the two lots is, particularly at certain times of the year, very striking, and they inevitably come to be recognised as contrasting aggregate types. It is true that there may not be absolute agreement between two commercial lots, and the variation from one lot to another is still greater in the case of indigenous, but the means for the extremes of the two groups have never been found to coincide nor even to approach each other at all closely.

These two " aggregate types " can then be used as standards to which other and less known types can be referred, and the results given below are intended mainly to show the difference in some fairly easily observed characteristics between British Commercial and British Indigenous in the first instance and then between these and other lots of different sources of origin.

(*a*) *Behaviour in the seedling year.* When seeds are spaced out for germination in boxes, it is noticeable that the " commercial " seedlings make more rapid early growth than the " indigenous ". Stapledon (9) has shown that tiller production is actually more rapid up to two months from sowing, but that at four months, six months, and fifteen months from sowing the number of tillers per plant is appreciably greater in the indigenous than in the commercial. That is to say, although growth is more rapid in the commercial, the indigenous form the denser plants.

The two general types also differ somewhat in the proportion of plants (all sown at the same time) which produce an abundance of inflorescences in the seedling year. In this respect, however, the extreme contrast is not between the two British groups but between the British Indigenous and some foreign nationalities, with British Commercial taking a somewhat intermediate position. This fact is brought out by the figures shown in Table III.

It is true that the difference between the two British types is quite marked, 7 per cent. in the indigenous as compared with 24 per cent. in the commercial, but there is a still greater difference between the latter and the New Zealand lots and particularly the Australian " Wimmera " Rye-grass.

The three lots 1418, 1865 and 1869 have been somewhat arbitrarily grouped together. The first of these (seed grown at Aberystwyth) is down to the minimum. Lot 1865 is known also to be once-grown, but it would appear to have undergone a definite change in type. Lot 1869 is provisionally assumed to be of this origin, although the seed was not described as such.

It would therefore appear that in the case of lot 1865 (i) the original seed was not average type, or (ii) the " once-grown " seed crop was harvested too early, or (iii) actual contamination from foreign pollen has occurred.

(*b*) *Date of emergence of inflorescence in the first harvest year.* The actual date adopted is that date when in the case of any particular plant at least three inflorescences show through the leaf sheaths. This particular date has been selected more or less arbitrarily and is not entirely satisfactory, mainly because it depends to a certain extent upon the vigour of the individual plant.

TABLE III. Percentage of plants producing Inflorescences in the seedling year.

Station number.	*Experiment number.*	*Origin.*	*Total plants.*	*Plants with inflorescences.*	*Per cent.*	*Group result.*
1689	B.179 : B.180	Station-bred pasture ...	50	0	0	0
1764	B.179 : B.180	British Indigenous ...	50	1	2	7
1868	B.100	British Indigenous ...	40	4	10	
1872	B.100	British Indigenous ...	120	9	8	
1413	B.179 : B.180	" Once-grown " Indigenous	50	0	0	21*
1865	B.100	" Once-grown " Indigenous	40	14	35	
1869	B.100	" Once-grown " Indigenous (?)	50	15	30	
1765	B.179 : B.180	British Commercial ...	50	10	20	24
1867	B.100	British Commercial ...	36	10	28	
1873	B.100	British Commercial ...	36	9	25	
1871	B.100	German Pedigree ...	46	15	33	33
1756	B.179 : B.180	Sandon, N.Z. ...	50	32	64	72
1874	B.100	N.Z. Commercial ...	43	35	81	
1863	B.100	Australian " Wimmera "	80	76	95	95

* See text.

because it is more vigorous, but because a plant with say a hundred tillers has presumably the chance of producing six inflorescences when a plant of fifty tillers produces three. When plants are of approximately equal vigour, this probably has little effect upon the general result, but if a lot contains an abnormal number of weak plants, the mean potential emergence date for that lot is somewhat earlier than that actually recorded.

The reason why the number " three " has been adopted is that, very rarely, a rye-grass plant may produce an inflorescence or two (rarely more) precociously, and the emergence of these does not appear to bear any definite relationship to general emergence. It would be safer from this point of view to adopt the number " six ", but any increase in the number required automatically adds to the difficulty of observation.

It is not claimed that date of emergence of inflorescences has any necessary relation to earliness of spring growth. What is claimed is that it indicates a definite growth stage. This is particularly useful where a comparison is to be made not only of bulk but also of proportion of stem to leaf or flowering to non-flowering tillers, since it ensures that comparison is made of plants or lots at the same stage of development. The mean date of emergence for a lot also does actually make it possible to classify " nationalities " in relation to each other, and to select for intercrossing those which agree in at least one important respect.

In most years, except where the plants are to be cut for " hay ", periodic rather than regular observations have been made, but in 1929 a considerable number of lots were closely studied (Experiment B. 100, 1928).

TABLE IV.

Date of emergence of inflorescences.

Station number.	*Origin.*	*Expt.*	*Number of plants.*	*Mean date.*	*Range of dates.*	*No. of weak plants.*
1865	British Commercial ...	B.180	25	4/5	25/4–15/5	4
1756	Sandon, New Zealand	B.180	25	6/5	28/4–21/5	2
1413	Once-grown Indigenous	B.180	25	27/5	5/5–15/6	1
1764	British Indigenous ...	B.180	25	29/5	21/5– 9/6	0
1689	Station-bred (pasture type)	B.180	28	30/5	25/5– 8/6	1
1774	British Commercial ...	B.100	74	9/5	1/5–22/5	6
1754	Station-bred (hay type)	B.100	89	12/5	6/5–29/5	1
1775	N.Z. (Canterbury) ...	B.100	58	12/5	6/5–22/5	7
1827	New Zealand (30 years old Bush sowing) ...	B.100	79	14/5	1/5–24/5	1
1828	N.Z. Commercial ...	B.100	75	15/5	8/5–27/5	5
1772	British Indigenous ...	B.100	68	23/5	8/5–10/6	2
1767	British Indigenous ...	B.100	93	24/5	6/5– 6/6	0
1778	British Indigenous ...	B.100	40	28/5	22/5– 7/6	0
1418	Once-grown Indigenous	B.100	56	28/5	17/5–10/6	1
1752	Station-bred (pasture type)	B.100	185	1/6	17/5–14/6	5
1753	Station-bred (pasture type)	B.100	194	8/6	22/5–14/6	6

The results are given in Table IV, together with those obtained from other smaller lots in 1928 (Experiment B. 180). In each case, the observations were made in the first harvest year, but in different seasons and in quite different positions. A strict comparison between the lots in the two experiments is, therefore, not permissible, although the one lot included in both experiments, lot 1418, shows only a difference in mean date of a single day. A single day difference is also found between lots 1689 and 1752, both actually representing the same Station-bred strains. The order in which the " nationalities " come in the two experiments is identical, with the exception that in B. 180 the once-grown indigenous is two days later than the indigenous, while it is rather distinctly later than two indigenous lots in B. 100 and of even date with the third. The three lots of indigenous in this case illustrate the variation between different lots of this type, but it will be observed that the difference is actually due to some plants in lots 1772 and 1767 being abnormally early, since the end dates correspond very well in the three lots.

It is interesting here to note that the New Zealand lots, particularly lot 1856, correspond rather well with British Commercial. Lot 1827 is perhaps definitely later, but is still much earlier than even the earliest indigenous. Lot 1828 contained a relatively high proportion of plants much below average vigour, and the potential date for this is very probably considerably earlier than that actually recorded.

This study of date of emergence of inflorescences has a direct bearing upon the question of strain-building and the purity of strains. It would seem that in at least one case of once-grown indigenous the general type has been somewhat modified, possibly through intercrossing with earlier-flowering types. This danger is, in any case, a very real one and is one of the greatest difficulties to be overcome in practical plant breeding. In the lots included in B. 100, 1928 (Table IV) the difference in mean date of emergence between the two extremes 1774 and 1758 is twenty-four days, but the latest plant (probably a weak one) of 1774 came into inflorescence on the same day as the earliest of lot 1758. There was, therefore, actual overlapping between the two lots. The difficulty, however, is greatly increased by the fact that " commercial " plants as a rule (as well as most other early flowering types) produce new inflorescences continually over a long period—in fact right through the season.[5] This means that even the earliest and the latest cannot be grown for seed side by side, nor in anything like close proximity to each other. This fact is of special importance in connection with the production of " once-grown indigenous " for the market, and would indicate that the character of a " strain " might easily be lost in one or two generations.

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[5] See below.

(c) *Flowering stems in the aftermath.* In " observation " experiments all the plants are cut back uniformly just in time to avoid seed-shedding in the earliest plants. This means that they are cut back at different growth stages, but since no weight or other determinations are made this is of little importance. It might, however, be expected to have some effect upon the type of aftermath produced. Theoretically, it might perhaps be expected that the early plants, which have been allowed the longer time for inflorescence production, would have exhausted their capacity in this direction, while the late plants would continue to produce flowering stems in the aftermath.

TABLE V.

Flowering stems in the aftermath. Experiment B. 100 (1928). Examined September, 1929.

Lot.	*Origin.*	*Mean date of emergence.*	*Number of plants.*	*Percentage of plants with*	
				$>$ 10 *inflorescences.*	$<$ 10 *inflorescences.*
1774	Commercial ...	9/5	68	68	82
1754	Station-bred (hay type)	12/5	83	10	90
1775	New Zealand ...	12/5	45	91	9
1827	New Zealand ...	14/5	79	72	28
1828	New Zealand ...	15/5	73	74	26
1772	Indigenous ...	23/5	66	23	77
1767	Indigenous ...	24/5	91	26	74
1773	Indigenous ...	28/5	39	15	85
1418	Once-grown indigenous	28/5	57	16	84
1752	Station-bred (pasture type)	1/6	101	3	97
1758	Station-bred (pasture type)	3/6	92	2	98

The figures in Table V show that this is not the case, and the early lots as a general rule are also those which produce an abundance of inflorescences in the aftermath, while the late lots produce very few. There is, however, no absolute correlation. The New Zealand lot 1775 contained only 9 per cent. plants which produced fewer than ten inflorescences in the aftermath, while the British Commercial, although of a somewhat earlier mean date, contained 82 per cent. The most striking figures, however, are those for the Station-bred lot 1754, which was the earliest but one, yet contained only 10 per cent. plants producing more than ten inflorescences per plant in the aftermath. In this respect this lot stands even below the ordinary indigenous and approaches the Station-bred pasture lots.

Apart from these lots there appears to be at least an association between earliness of emergence and aftermath inflorescences, although the two New Zealand lots 1827 and 1828 stand slightly higher than the earlier British commercial. The difference in this case is evidently too small to be considered of any significance, and as far as this character is concerned these three lots belong to the same general type.

Between these lots and the indigenous there is a very marked difference, whilst amongst the indigenous themselves there is a fair degree of agreement except again that the later lots have fewer inflorescences.

It is evident that, as a general rule therefore, with ordinary lots (as apart from Station-bred lots), the earlier lots are the most stemmy, since they produce an abundance of flowering stems both early and late, while the later lots only produce one crop of inflorescences.

(*d*) *Yield results with single plants.* This characteristic can be studied in a very general way by observation, but this method gives no actual figures. Actual yield data can only be obtained by very laborious methods, and, as already stated, this method is rarely resorted to except in the case of Station-bred lots. Some results, however, have been more or less incidentally collected. In Experiment B. 150, two Station-bred lots, three British Commercial, two British Indigenous and one lot of the Norwegian strain " Jædersk " were included. This was a " hay " experiment. A preliminary cut representing winter and early spring growth was taken at the end of March. Observations were then made and the " emergence date " of each plant was noted. With this date as the basis, each plant was cut for hay at a fixed date, allowing the same growth interval for each plant between emergence and cutting for hay. The same procedure was followed with the first aftermath cut, while the second aftermath cut was taken at the same time for all plants, thus making it possible to compare seasonal productivity.

In Table VI the results are grouped according to the origin of the lots. The British Commercial is then taken as the standard for comparison at 100 at each cut.

The plants of each lot were scattered regularly over the whole area in order that, as far as possible, the effect of soil differences might be eliminated.

TABLE VI.

Single-plant yield results. Imitation "hay" conditions. Experiment B. 150.

Origin.	*Number of plants.*	*Mean emergence date.*	*Preliminary cut.*	*Hay cut.*	*First aftermath.*	*Second aftermath.*	*Total.*
Station-bred " hay "* ...	50	6/5	167	123	140	156	144
British Indigenous ...	50	21/5	99	137	136	83	118
British Commercial ...	75	7/5	100	100	100	100	100
Jædersk ...	25	5/6	40	105	97	34	71

* F_1 families from selected plants.

The Station-bred lots stand well apart from the others and show a most remarkable productivity in the winter and early spring growth period and in the aftermath, as compared with commercial. The hay cut for the indigenous was, on the average, taken about fourteen days later than the commercial and the Station-bred lots, so that the higher hay yield represents a longer growth period. At the other end of the season, the lower figure for this lot represents a shorter interval. For the season, however, there is an excess over commercial of 18 per cent. even under " hay " conditions. " Jædersk ", being exceptionally late, shows to advantage only after the longer " hay " growth interval.

Thus as far as the two groups commercial and indigenous are concerned, the best results have been obtained from the latter.

The same commercial and indigenous lots were included in Experiment B. 151. Jædersk was also again included, but the two Station-bred lots were now replaced by two other F_1 lots of the " pasture " type.[6] This experiment differed from B. 150 in that all plants were cut at short intervals throughout the season in imitation of pasture conditions. No allowance was made for earliness or lateness.

The relative green weights for each group at each cut are shown in Table VII.

Again the Station-bred lots stand well apart from the others, while the indigenous lots show a greater excess over ordinary commercial under pasture than under hay conditions.

Jædersk has again, even under pasture conditions, failed to

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[6] That is, families bred from plants selected with a view to the production of an improved " pasture " strain.

TABLE VII.

Single-plant yield results. Imitation "pasture" conditions. Experiment B. 151.

Origin.	*Date of cuts with relative weights.*							
	8/4	8/5	8/6	2/7	29/7	26/8	22/9	*All cuts*
Station-bred ...	149	189	221	214	228	182	180	178
Indigenous ...	116	118	150	144	155	145	156	131
Commercial ...	100	100	100	100	100	100	100	100
Jædersk ...	37	66	90	89	94	103	115	64

show to advantage, although towards the end of the season it improved considerably.[7]

In Experiments B. 179 and B. 180, Station-bred strains (not F_1 families), indigenous, commercial and a New Zealand (Sandon district) lot were included. Experiment B. 179 was conducted upon the " imitation pasture " basis, and B. 180 on the " hay " basis. The details were very similar to those for Experiments B. 150 and B. 151 and need not be repeated. The relative yields (green weights) given for the season by the different lots are shown in Table VIII.

TABLE VIII.

Relative yields of certain nationalities and strains under single-plant conditions. Experiments B. 179 and B. 180.

Origin.	*B. 179. " Pasture."*	*B. 180. " Hay."*	*Total.*
Station-bred (pasture type)	197	—	—
Station-bred (pasture type)	192	166	177
British Indigenous ...	121	131	127
New Zealand (Sandon) ...	138	114	124
British Commercial ...	100	100	100

As far as the commercial and indigenous lots are concerned these results are in general agreement with others. The results for the Station-bred lots are given only as a matter of interest, but those for the New Zealand lot are of considerable importance.[8]

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[7] Both in this experiment and in B. 150 Jædersk suffered from a serious rust attack in the previous autumn. It is particularly susceptible to rust when spaced out as single plants.

[8] See below.

Each lot in each experiment consisted of twenty-five plants, so that too much emphasis must not be placed upon the fact that, rather contrary to expectation, the New Zealand lot has outyielded the indigenous under " pasture " conditions, while the reverse is the case under " hay " conditions. The means for the two experiments agree very closely. Thus this New Zealand has given results distinctly better than the ordinary commercial, although in date of emergence of inflorescences, as is usual with New Zealand lots, it agreed very closely with the latter.[9]

Differences in stemminess of herbage are discussed in the following section.

(*e*) *Stemminess of cut herbage* (*single plants*). The herbage of each plant in Experiment B.150 at the hay, first aftermath and second aftermath cuts was separated into flowering and non-flowering tillers and the *numbers* ascertained by counting. As a representation of stemminess, the figures $\left\{\frac{\text{flowering tillers}}{\text{non-flowering tillers}}\right\}$ may then be used, and when the commercial is taken at 100 the relative figures for other nationalities can be shown. The results for lots in Experiment B. 150 are given in Table IX.

TABLE IX.

Relative stemminess of lots in experiment B. 150.

Origin.	*Hay cut.*	*First aftermath.*	*Second aftermath.*
Station-bred ...	32	1	0
Indigenous ...	74	41	4
Commercial ...	100	100	100
Jædersk ...	67	1	0

It will be borne in mind that, as judged by date of emergence of inflorescences, both the hay cuts and the first aftermath cuts were made at equivalent growth stages, and yet there is a very marked difference between one group and another, the commercial being outstanding as the most stemmy, and this in spite of the fact that it was lower in total yield than either the Station-bred lots or the indigenous. These figures are in full accord with the observation results and show that the commercial persists in sending up flowering stems to a far greater extent than the indigenous.

Six lots in experiment B. 151 were also examined for stemminess, but the method used in this case was different. The herbage was now separated into " leaf " (=leaf laminae) and

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[9] See Table IV.

" stem " (=stem proper with leaf sheaths). The separations were ovendried and weighed. When the figures for stem/leaf are worked out, without here going into details for the various cuts, the relative " stemminess " figures are as follows :—

Commercial	=	100
Station-bred	=	86
Indigenous	=	82
Jædersk	=	67

Thus, with a far greater yield from the Station-bred lots (see Table VII) the herbage was yet less stemmy. The yield in the case of the indigenous was also considerably greater than that of the commercial, but Jædersk gave a low yield.

It has been shown that in the " pasture " experiment B. 179 the yield increased successively from commercial, through indigenous, New Zealand (Sandon) to Station-bred (two lots). The relative stemminess of the five lots, based upon the three mid-season cuts (when practically all the flowering stems would be included) taking the lots in the order given above were 100, 46, 94, 20 and 28. In the hay and first aftermath cuts taken together (B. 180) (representing equal growth stages) the relative figures were 100, 76, 89 and 54.[10] In both experiments, therefore, the New Zealand rather closely approaches the commercial while the indigenous is far less stemmy, and Station-bred pasture strains still less so.

This New Zealand lot, therefore, shows some superiority over British Commercial in both yield and leafiness, but in the latter characteristic it does not approach the indigenous at all closely.

V. Characteristics of different " nationalities ".

From the study of the data given above, together with general observations and some definite data not included, it is now possible briefly to describe some of the aggregate characteristics or general types of the various nationalities. The greatest amount of information has been obtained in the case of the British Commercial and the British Indigenous. Since these are also strongly contrasting types they will serve as standards for the placing of other lots.

British Commercial. Individual plants vary considerably, but together they form a distinctive general type. In the seedling year they start off at a rapid rate, but do not tiller very profusely. A rather high proportion of the plants will produce an abundance of inflorescences in this seedling year, but such plants are not necessarily " non-perennial " in general morphological characters, although some Italian-like plants may occur.

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[10] Only one of the two Station-bred strains was included in this experiment.

In the first harvest year the plants start growth earlier in the season than most others, and the inflorescences appear at an early date. The hay produced is very stemmy, as also is the herbage if the plants are cut frequently during the season. A high proportion of the plants also produce an abundance of inflorescences in the aftermath, and at this time the plants show the greatest variation amongst themselves. The three plants shown in Fig. 1 may be regarded as typical. At one extreme is the very stemmy plant with practically no leaf, and most grades between this and the centre plant showing a good combination of flowering and non-flowering tillers can be found. There is again a grading down to the plant with very few aftermath inflorescences. Under ordinary field conditions, as is well known, this general type is very non-persistent, and its herbage either as hay or as pasture is very stemmy.

British indigenous. The variation from plant to plant within a lot described as " indigenous " or " wild " may be even greater in some respects than in the case of " commercial ", and here again Italian-like plants sometimes occur.[11]

In the seedling year growth is at first somewhat slower than in the commercial, but soon the plants tiller more profusely and become much more dense. Relatively few plants produce an abundance of inflorescences in the seedling year, but different lots show some variation in this respect.

In the first harvest year the inflorescences are later in emerging, the mean date being typically a fortnight or more later than commercial. The herbage, whether studied as " hay " or as " pasture " is decidedly less stemmy although the yield is quite appreciably greater. Few plants produce an abundance of inflorescences in the aftermath and the extreme stemmy type of the commercial is rarely, if ever, found. The two plants shown in Fig. 2 represent in a general way the extreme types, but there is variation around and in between these two.

Under field conditions the yield is higher and the persistency greater than in the commercial.

Jædersk. This strain is considerably grown in the Jæren (south-west) district of Norway.[12] It was developed locally from supposedly indigenous plants and appears to suit the conditions very well.

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[11] There is some reason to suspect that such seed is not always true indigenous but rather " once-grown ", where a small amount of Italian has been used in seeding down. Another possible source of Italian-like plants would be winter-feeding of stock on hay from a temporary ley.

[12] Perennial rye-grass is not used in Norway except in the comparatively mild climate of this district. For other districts no strains sufficiently winter hardy have yet been discovered.

At Aberystwyth its behaviour in the seedling year is very similar to the extreme late indigenous, although it is rarely as bulky or as dense. In the autumn also it is typically subject to rust (*cf.* Witte (18)), but even when it escapes this disease it becomes discoloured much earlier in the autumn than plants grown from British seed.[13]

Under winter conditions there is some improvement, particularly if frost and snow occur, and the greener appearance of the Jædersk single plants after the severe weather of February, 1929, was particularly marked.

It is probable that under field conditions Jædersk suffers somewhat less from autumn rust, but even here the attack may be quite severe.

In the first harvest year, Jædersk is very late coming into inflorescence, following a late spring growth. The hay is relatively leafy and very few or no inflorescences are produced in the aftermath. It therefore rather closely resembles the extreme late type of the British Indigenous, but the plants are less bulky and less dense. So far, no indication has been found that it is in any way superior to British Indigenous.

Svalöf Victoria. This pedigree strain has not been extensively studied as single plants. It is, on the average, definitely later in coming into inflorescence in the first harvest year than the British Commercial but somewhat earlier than the indigenous. It does not withstand autumn and winter conditions at Aberystwyth so well as the two British groups, but it recovers well. In one small trial with garden plots here recorded it gave results which were at least no better than British Commercial but it cannot definitely be stated that this result is of general application. From general observation, coupled with some early results obtained, it would be considered to be somewhat superior to British Commercial but inferior to British Indigenous.

Danish Lundbäk. This Danish pedigree strain has been the least successful of all at Aberystwyth except perhaps " Class B ", New Zealand. It makes very rapid growth in the seedling year, but in some cases a relatively high proportion of the plants have failed to survive the winter.[14] Surviving plants often recover well and make very rapid growth in the first harvest year, resulting in a heavy hay crop. The plants then suddenly die out in many cases and practically no aftermath is produced. It is, in fact, with " Class B ", New Zealand, Argentine Rye-grass and Wimmera Rye-grass (see below) the least valuable type studied at the Welsh Plant Breeding Station.

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[13] Red fescue seed collected in Norway gave plants which similarly became badly discoloured early in autumn, and some Finnish lots have behaved in the same way.

[14] It must be borne in mind that " winter hardiness " has quite a different meaning at Aberystwyth from that in general use in Scandinavia. In West Wales it does not usually mean resistance to frost but rather to changeable conditions with sudden changes from extreme wet to sharp frost.

New Zealand. New Zealand Rye-grass at its best may at once be stated to be very good; at its worst it is very bad. In fact, two rather distinctive sub-groups must here be recognised although the difference is more in the proportions in which good and poor plants occur than in a difference of plant type. In the first subgroup must be placed certain samples received under the district names of Hawke's Bay, Poverty Bay and, to some extent, Sandon. These may be referred to as " Class A ".[15] In the second group have been placed plants known to have originated in the Sandon, Canterbury and " Southland " districts, together with a few lots of unknown origin. These may be referred to as " Class B ".

" Class A " lots very closely resemble British Commercial in general characteristics—behaviour in the seedling year; date of emergence of inflorescences in the first harvest year; and the production of inflorescences in the aftermath. Representative plants of this sub-group are shown in Fig. 8, and it will be seen that the agreement with British Commercial is very close.

Under small plot conditions, however, one New Zealand lot has given definitely better results than British Commercial, while another lot has given similar results under single-plant " pasture " and " hay " conditions. When groups of single plants are kept under observation side by side some of the New Zealand lots of this class are seen to be more vigorous than British Commercial, particularly in the aftermath.

The " Class B " New Zealand differs in aggregate or average behaviour from " Class A " and British Commercial, first of all in the fact that a decidedly higher proportion of the plants rush into full inflorescence in the seedling year and even in that year become excessively stemmy. These plants cannot be said to differ essentially in morphological characters from extreme plants found in " Class A " New Zealand and British Commercial, and they generally persist into the first harvest year. By that time, however, they are lacking in vigour and apparently cause the mean date for emergence of inflorescences to lag behind when it should

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[15] It would be dangerous to apply district names to these classes since from one and the same district good and bad lots may be obtained. (See Levy and Davies (5).)

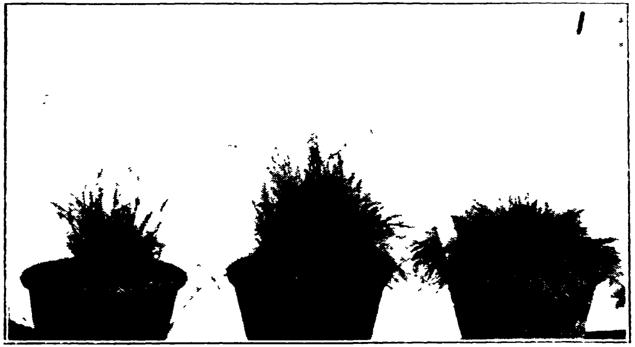

Fig. 1. British Commercial.

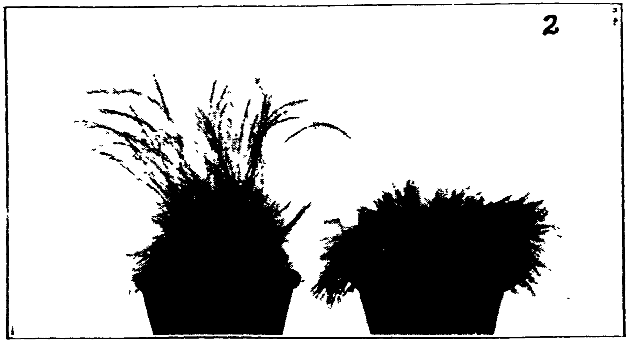

Fig. 2. British Indigenous.

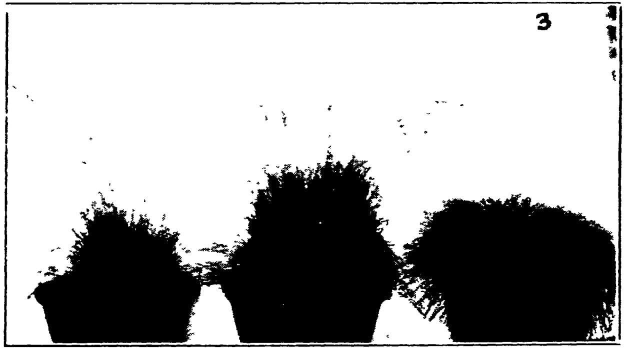

Fig. 3. “ Class A ” New Zealand.

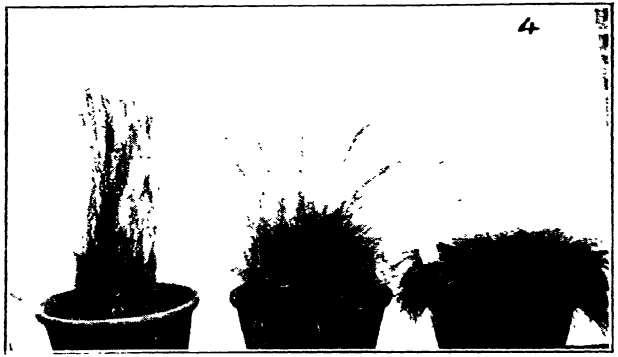

Fig. 4. “ Class B ” New Zealand.

be about as early as that of British Commercial. The produce in the first harvest year is poor in bulk and excessively stemmy, and most of the plants, after cutting, again rush into full inflorescence in the aftermath. Fig. 4 shows three aftermath plants, but the extremely stemmy plant included shows greater vigour than the average for its type. Actually, the plants here shown do not differ at all appreciably from those of " Class A " New Zealand and British Commercial, but the appearance of the lot itself was decidedly poorer throughout the season.

Plants which have some of the characteristics of Italian rye-grass are frequently found, but judged on the Italian standard they are again poor.

The fact that these two extreme classes exist under the name " New Zealand " is of grave importance both to the British agriculturist and to the export trade of the Dominion. Most of the lots so far studied at the Welsh Plant Breeding Station have been obtained direct from individual correspondents in New Zealand and they therefore do not necessarily represent the bulk of New Zealand seed. The only two samples received through ordinary distributing channels have proved to be of the " Class B " type. This is really what would be expected since, according to Stapledon (11), Sandon and Poverty Bay seed already commands a higher price than Southern on the New Zealand market. It therefore follows that when seed is available for export to this country it will very largely be of the inferior " Class B " type.

It appears that such seed, at least in some seasons, can be placed upon the British market at a price which compares favourably with ordinary British Commercial. The sample is also as clean and attractive as the British grown and will probably find a ready sale—to the detriment of British agriculture and, eventually, of the Dominion's export trade.

This variation in the type of New Zealand seed cannot be over-emphasised, and while the British farmer can with every confidence be urged to use " Class A " New Zealand seed and with equal confidence to reject " Class B " New Zealand seed there is, as yet, no sure means by which he can differentiate between them in the sample. Consequently, the advice that must be given to the British farmer is that he should use New Zealand Rye-grass seed, which is merely described as such, only with the greatest caution. If, on the other hand, one might presume to offer advice to the Dominion in the matter of exporting seed to this country, it would be this : " Do not export any of the ' Class B ' type; export only seed from such areas as produce the ' Class A ' type, and see that in these areas the poor types are rigidly excluded ". The latter part of this advice appears in fact to be superfluous, since the New Zealand research workers, as shown by Levy and Davies (5) are fully alive to the importance of retaining the high quality of the best, and, if possible, to improve upon it.

It is interesting to speculate upon the possible origin of these two types of New Zealand Rye-grass. It may probably be assumed that the original seed used in sowing cleared " bush " areas was the ordinary British Commercial Perennial Rye-grass, and there is no reason to suppose that the British Commercial, on the average, is appreciably different at the present time from what it was say forty years ago. In fact, it would appear to have developed into a general " ecotype " suited to the artificial conditions under which the seed is generally produced.

From the general type so developed, the " Class A " New Zealand has departed very little, but the influence of the long-duration pasture conditions has apparently caused a change towards greater vigour and greater persistency. This change has probably been brought about through some elimination of the poorer types found amongst British Commercial. On the other hand, the change is not directly towards the British Indigenous type. This may be due to the difference between pasture conditions in the Dominion and those in England, or it may be that the length of time which has elapsed has been too short for the change towards British Indigenous to be as yet appreciable. The most probable explanation, however, appears to be that the genotypes forming the British Commercial are very far removed from those forming the British Indigenous and that no re-combination of factors within this general group can reproduce the indigenous type. When, then, as in the case of New Zealand, this type has been isolated, and there is no possible means of intercrossing with the indigenous type, there is no direct route by means of which reversion can take place.

The " Class B " New Zealand type presents a different problem, but here it is possible that the conditions have favoured the poorer sub-types in the British Commercial. That is to say, they have favoured rapid growing, early seeding and short lived types. Such types apparently do exist in small quantities in British Commercial at the present day, but it is doubtful whether they are of such an extreme character as the New Zealand. It is further possible that they have been developed through the intercrossing of the " commercial " and Italian. The present writer has shown that, given the opportunity, Perennial and Italian Rye-grasses intercross quite readily and that the hybrids are fertile (4). F_1 families from this type of cross have been studied to a certain extent, and amongst them were found plants which were classified as " weak ". These made relatively small growth, were very stemmy and by no means unlike the main " Class B " New Zealand plants. Whether this is a constant result of the intercrossing of Perennial and Italian is not known.

" Wimmera " Rye-grass. This rye-grass does not properly fall within the scope of the present survey, since it is generally recognised as a short-lived type.

Seed samples received at the Welsh Plant Breeding Station have been described simply as " Wimmera " Rye-grass or with the addition of the supposed equivalent, " *Lolium subulatum* ". Such lots, when sown, have invariably produced a mixture of types. One lot of single plants raised from seed obtained from an Australian correspondent was under observation in 1929, when 95 per cent. of the plants rushed into full inflorescence in the seedling year, and this quite early in the season. The plants were then cut back, after which some of them again produced a few weak inflorescences while others simply perished. Most of the plants constituting this 95 per cent. of the population were dead by September and had behaved throughout as strict annuals. Under Aberystwyth conditions, although rapid growing and early maturing, they produced but a very small bulk of herbage.

Other plants in the population closely approached the Italian rye-grass type (of poor quality) while some others closely resembled certain types of Perennial Rye-grass.

Experience with this lot is exactly similar to that with other lots previously received and is in full agreement with the plot results given above. In all these cases, therefore, the name " Wimmera " simply covers a mixture of types, with a preponderance of poor, rapid-growing, short-lived plants which give a very stemmy herbage.

The somewhat striking similarity between the " Wimmera " lot studied in 1929 and a " Class B " New Zealand lot studied at the same time could not be overlooked. The " Wimmera " was certainly the poorer lot, but the extreme short-lived type of the " Wimmera " appeared to correspond with the extreme stemmy, but less strictly annual, type of New Zealand. The question then arises whether this mixed " Wimmera " is a still more specialised form of the " Class B " New Zealand or are the two more or less parallel types developed under different conditions.

Since the preponderating type found in " Wimmera " Rye-grass, as judged by all samples received, did not appear to conform to the descriptions of " *Lolium subulatum* ", Professor Stapledon kindly undertook during his visit to the Commonwealth to procure a seed sample of true " Wimmera " type. He was successful in obtaining a herbarium specimen inflorescence from Mr. Mullet, of the Department of Agriculture, Victoria. The plant from which this inflorescence had been taken had obviously made very robust growth, and its characteristics at once suggested a form of *Lolium temulentum*, of which, according to Grenier and Godron (2) *L. subulatum* Vis. (= *L. oliganthum* Nob.) is a variety. It also seemed quite conceivable that the inflorescence had been taken from just such a plant as that shown by Breakwell (1) as representative of " Wimmera " Rye-grass (*L. subulatum*).

Seeds from this inflorescence germinated quite readily, and seedlings were grown both out of doors and under cool greenhouse conditions. In both cases the plants produced but few tillers, all of which developed inflorescences in the seedling year. From these a further generation was raised in the following year, and the plants obtained agreed with those of the first generation and failed to produce the robust growth of the original inflorescences. In fact, all the plants grown at Aberystwyth were very small, in no case exceeding nine inches in height, with very stiff stems and very little leaf. In every particular they appeared to agree with *Lolium rigidum* as illustrated by Breakwell (1) rather than with *L. subulatum*, and Wenholz and Whittet (12) actually consider " Wimmera " Rye-grass to be the variety *strictum* of *L. rigidum*.

It would therefore seem that the herbarium specimen received does actually represent what is regarded as true " Wimmera " Rye-grass, and yet in none of the samples of " Wimmera " actually received has this type of plant appeared. The predominating type in these samples agrees with the standard only in general behaviour. It is a rapid growing, stemmy annual, but its inflorescence has no similarity to that of *L. temulentum* and its allies.

In practice, therefore, the name " Wimmera " stands for any rapid-growing, short-lived rye-grass, but none of the types met with appear to have any particular value under Aberystwyth conditions as the bulk, characteristic of " Wimmera ", cannot here be reproduced.

Argentine Rye-grass. A few samples have been received under this description, but they have not been extensively studied. In general behaviour they have agreed very closely with the " Class B " New Zealand aggregate type and have shown no properties to recommend them for use in this country. At best they only give a good growth in the seedling year, and then, after producing a scant, stemmy herbage in the first harvest year, quickly disappear.

In conclusion, I wish gratefully to acknowledge my indebtedness to my colleague Mr. A. R. Beddows, B.Sc., who superintended the operations in connection with Experiments B. 150, 151, 179 and 180, and to Mr. J. W. Watkins, Superintendent of the Farm and Gardens, in connection with Experiment B. 165.

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THE EFFECT OF DIFFERENT CUTTING AND MANURIAL TREATMENTS ON THE TILLER AND ROOT DEVELOPMENT OF COCKSFOOT.

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AND

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The experiment (B. 184) here reported upon was designed to supplement previous tests[1] conducted at the Station as to the effect of inorganic nitrogenous manures in relation to the tiller and root development of cocksfoot. The chief modification made in the present trial was that the nitrogenous manure was applied in incremental doses throughout the season instead of in one dressing.

Material and methods.

The experiment was conducted on single spaced plants. Seed of a relatively pure-breeding pedigree indigenous strain was sown in boxes in January, 1927. The seedlings were planted out in spaced rows in May of that year. The plants were well established by the autumn and the experiment proper was commenced in March, 1928. Twenty rows of the plants (in two sections of ten rows each) were manured with nitro-chalk at monthly intervals from March to October. The dressings were approximately at the rate of 1½ cwt. per acre each month, the total application for eight dressings therefore being 12 cwt. per acre. This excessive manuring was adopted in order to ensure maximum response, and in order, as far as possible, to provide abundant available nitrogen for the plants throughout the growing season. No phosphoric or potassic manures were employed. Buffer rows separated the two " nitrogen " sections from the " control " sections, and the outside rows of the block were also treated as buffer plants.

The experimental plants were used to collect data on three main terms of reference as follows : –

I. To ascertain the incremental tiller and root development from April 2nd to October 1st on treated and control plants respectively.

II. To compare the effect of cutting to ground level, and to a height of six inches at three weekly intervals with the effect of cutting for hay and aftermath on tiller and root development on treated and control plants respectively.

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[1] See references to literature cited at the end of the article.

III. To compare the effect of keeping the inflorescences continually plucked to that of the various cutting treatments on tiller and root development on treated and control plants respectively.

Discussion of results: incremental tiller and root development.

Five of the " nitrogen " plants and five of the " control " plants were dug up at fortnightly intervals from April to October. None of the plants used for this purpose were cut back during the period of experimentation. Tiller counts were made on the plants immediately they were dug up. They were then docketed and dried until the winter, when the roots were washed clean from the soil, and both roots and tops were weighed. Cocksfoot is a grass very suitable for an experiment of this sort, for with care the roots can be dug up with very little wastage and the washing and cleaning can also be conducted with the minimum of root loss.

The data collected by these means are set out in Table I. As it was only possible to use five plants at each digging and as there was some soil irregularity the results have been presented in the table for each nitrogen section with its adjacent control section separately. By adopting this method of presentation the effects of soil irregularity have been smoothed out, but monthly instead of fortnightly increments of growth have necessarily to be shown.[2]

In broad outline the results from the two sections will be seen from examination of the table to be in marked agreement. Taking the results as a whole, it will be noted that the yield of tops (stem and leaf), number of tillers, and root weight have been considerably increased by the application of nitrogen; and that the greatest increase has shown itself at the heading-hay-ripening-period, *e.g.*, in the June, July and August liftings.

Both in the case of the nitrogen and control plants yield of tops, tiller production and root development have been progressive all through the growing season from early April to the end of September. It is at first sight surprising that the August and September (including the lifting on October 1) yields should have been higher than the July (hay time) yields and even more surprising that the September yields should have been higher than those of August. The plants were, however, of the leafy indigenous type with a capacity for prolonged leaf production

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[2] The method of lifting adopted was to dig from one of the nitrogen-control sections one fortnight and from the other nitrogen-control section the next fortnight.

TABLE I.

To show (1) the average weight of tops (= stem and leaves) in gm. per plant air-dry weight, (2) the average number of tillers per plant, and (3) the average weight of roots in gm. air-dry weight per plant for control and nitrogen sections on the basis of monthly increments throughout the growing season.

Section A.								Section B.							
		With nitrogen.			*Without nitrogen.*					*With nitrogen.*			*Without nitrogen.*		
Dates.		*Wt. of tops.*	*No. of tillers.*	*Wt. of roots.*	*Wt. of tops.*	*No. of tillers.*	*Wt. of roots.*	*Dates.*		*Wt. of tops.*	*No. of tillers.*	*Wt. of roots.*	*Wt. of tops.*	*No. of tillers.*	*Wt. of roots.*
Apr.	2	—	83	3.1	—	91	3.0	Apr.	16	—	41	2.3	—	116	3.7
Apr.	30	40	116	4.1	—	98	2.5	May	14	—	97	3.8	—	83	2.0
May	28	80	118	4.7	57	118	3.9	June	11	66	139	4.3	67	138	5.2
June	25	132	135	7.4	96	129	7.1	July	9	87	156	10.7	93	150	7.3
July	23	135	170	10.0	86	127	7.5	Aug.	6	141	140	13.7	98	160	11.5
Aug.	20	190	225	17.4	90	128	9.8	Sept.	3	161	176	20.9	110	202	15.9
Sept.	17	232	225	22.7	101	134	12.9	Oct.	1	161	217	20.9	140	174	18.5

and thus the development of " aftermath " leafage more than counterbalanced a certain rotting off of the hay crop and subsequent shedding of the seed crop.

It is perhaps of practical significance to observe that on the average of all the figures (nitrogen and control on both sections) the weight of roots per plant during the aftermath period (*i.e.*, subsequent to normal date of hay cutting—*vide* late July, August and September liftings) was found to be twice as great as that in the pre-aftermath period (*i.e.*, previous to the normal hay cutting date—*vide* June and early July liftings). This evidence that root development is progressive throughout the season in the case of plants allowed unhampered growth and consequently of the extent of the root system during the aftermath period would thus appear to be an interesting commentary on the soundness of the practice now strongly advocated, especially by Scandinavian workers, of applying farmyard manure or other nitrogenous dressings to meadows on the aftermath—that is to say, of applying such fertilizers when the plants have their maximum root range and are still capable of active assimilation and growth. During the winter and early spring, growth and therefore necessarily assimilation are at a low ebb, while the evidence here discussed would suggest that the range of live and functioning roots is then also greatly restricted. In this connection it may be remarked, in passing, that evidence from sward plots under incremental grazing also tends to suggest that it is an early autumnal rather than a very early spring dressing of inorganic nitrogen that most favours the production of "early grass" in the spring.

To compare the effect of three different methods of cutting.

For this part of the trial ninety-five plants constituted the experimental unit for each of the following systems of cutting :—

(1) Cutting to ground level every three weeks (April-October).

(2) Cutting at a height of 6in. every three weeks (May-October).

(3) Cutting twice—hay and aftermath.

In the case of the plants cut to ground level the first cut was made on April 2nd and ten cuts were made during the season. There was no growth 6ins. high until May 14th, when the first cut of this system was taken, consequently only eight three weekly cuts were possible during the season—at every date subsequent to May 14th the incremental growth had attained to 6ins. The cutting to 6ins. was rendered accurate by the use of a small grid specially made for the purpose.

The produce of each cut was air-dried and weighed, and after the last cut in October all the plants were lifted and tiller

TABLE II.

To show the effect of three methods of cutting cocksfoot and of plucking the inflorescences as exserted on (1) yield of tops (= stem and leaf), (2) number of tillers produced at the end of the season, (3) weight of roots at the end of the season, and (4) to show in the case of the hay plants and of the "plucked" plants the number of inflorescences. The results are given separately for "nitrogen" and "control" plants. On the following page the weight of roots per 100 tillers is shown.

Treatment.			*Weights and numbers per plant.*							
			With nitrogen.				*Without nitrogen.*			
	Date of first cut.	*No. of cuts.*	*Dry wt. in gm.*	*No. of tillers.*	*Wt. of roots in gm.*	*No. of inflorescences.*	*Dry wt. in gm.*	*No. of tillers.*	*Wt. of roots in gm.*	*No. of inflorescences.*
Cut to ground level every three weeks ...	Apr. 2	10	78.9	152	1.8	—	52.5	138	2.1	—
Cut to six inches every three weeks ...	May 14	8	106.4	230	6.9	—	72.0	204	5.8	—
Hay cut and aftermath cut ...	June 20	2	212.0	230	10.9	49.2	115.0	165	6.6	41.7
Kept plucked of inflorescences and cut back once	July 20	1	138.0	297	16.0	68.8	82.0	269	10.6	51.9

counts immediately made; while after proper drying and washing, the root weights were ascertained.

The data obtained from these various treatments, both for the " nitrogen " and " control " plants are set out in Table II. In this case all the plants were dug at the same time and the experimental unit (ninety-five plants) was large, consequently the separate sections have been averaged together. In view of the further fact that the experimental plants had been drawn from both sections equally it follows that the results of soil irregularity have been reduced to a minimum.

Average weight of roots per 100 tillers in gm.

	With nitrogen.	*Without nitrogen.*
Cut to ground level ...	1.18	1.52
Cut to six inches ...	3.00	2.84
Hay and aftermath ...	4.74	4.00
Kept plucked ...	5.40	4.00

The results show, as has been demonstrated in previous trials, that a much greater response to nitrogen is given in the hay and aftermath than in the sum of pasture cuts, and consequently the ratio hay *cum* aftermath to pasture is not affected in favour of pasture—thus relatively a system of oft repeated cutting reduces gross yield just as much under the application of nitrogenous manures as when these are withheld in both cases (hay and pasture).

Cutting at 6 ins. instead of to ground level has been responsible for an increase of gross yield of about 35 per cent. both on the control and on the nitrogen plots—this is on all fours with results previously obtained, when cutting to 2 ins., instead of to ground level, gave an increase of 20 per cent. on a seven cut system.

In the trial under review the application of nitrogen would appear to have increased the root weights (confirmed also by the results previously discussed) of the hay and aftermath plants and of those cut at 6 ins. but not in the case of those cut to ground level. In previous trials with a single dressing of nitrogenous manure there was no evidence of increased root weight even in the hay and aftermath plants. The number of tillers *per* plant has been considerably increased by the addition of nitrogen in the case of the close cut, the cut to 6 ins., and the hay *cum* aftermath plants—a result in keeping with previous trials.

In both the " nitrogen " and " control " plants it will be seen that the least number of tillers and the lowest root weight per plant occurs on those plants most drastically treated—namely those cut ten times to ground level. It is exceedingly interesting and significant to note that the plants repeatedly cut to 6 ins. have produced as many as or more tillers than those cut twice (hay and aftermath), and have developed three times (nearly three times on the control plots and over three times on the nitrogen plots) as much root as those closely cut, and have approached much more nearly to the root weight of the hay *cum* aftermath plants.

Reference to the statement at the bottom of Table II suggests that the altogether greater root weight of the plants cut for hay and aftermath than of those cut to ground level on a pasture system is not merely a function of the greater number of tillers of the former plants but that the actual amount of root produced per tiller is considerably greater in the hay *cum* aftermath plants in which plants it is also appreciably greater than in the pasture plants cut to 6 ins.

To compare the effect of continually plucking the inflorescences to that of various systems of cutting.

The data relative to this method of treatment are shown in Table II together with those for the three systems of cutting (previously dealt with). As with the cutting systems 95 plants have constituted the unit of experimentation.

The yield cannot of course be compared with that of hay or aftermath as the plants were cut back at an intermediate period; the yield was, however, heavy and (although the produce was devoid of panicle bearing shoots) was greater than that from either of the pasture systems.

The point of chief interest and the point which it was intended to test is that tiller production per plant has been greater when panicles were continually plucked than when hay and aftermath was taken and altogether greater than under either system of pasture cutting. The root weight per plant has also been heaviest under this method of treating the plants. A further fact of interest emerges inasmuch as plants from which the panicles are plucked as soon as they exsert develop a greater number of panicles than do those left to produce a normal hay crop. More panicles, more tillers and a greater weight of roots per plant were produced by the " nitrogen " than by the " control " plants, and since the same was true of the hay plants the importance of nitrogenous dressings applied to indigenous cocksfoot for seed production is again emphasised.[3]

The frequency of panicle exsertion was the same on the

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[3] See Stapledon (2).

" nitrogen " and " control " plants. Exsertion commenced during the week ending May 14th; over 50 per cent. of the panicles were exserted between May 14th and May 21st. During period May 22nd to May 28th 33 per cent. of the panicles were exserted; exsertion then fell off rapidly and finished completely during the week ending June 20th.

Summary and conclusions.

(1) When plants of indigenous cocksfoot are allowed unhampered growth as widely spaced individuals from April to October, yield, root and tiller development are progressive throughout the season. Nitrogen applied as nitro-chalk in heavy incremental dressings has had the effect of increasing yield, root and tiller development.

(2) Plants cut eight times to 6 ins. have considerably out-yielded those cut ten times to ground level on the basis of gross yield per season.

(3) Plants cut twice as hay and aftermath have out-yielded the sum of the pasture cuts from the 6 ins. system and from the ground level system.

(4) The effect of nitrogen applied as nitro-chalk in heavy incremental dressings has been more pronounced on the yield of the hay *cum* aftermath plants than on that of the pasture plants; all systems of cutting have, however, shown a decided response to nitrogen.

(5) Tiller and root development have been nearly as good under a pasture system cut at 6 ins. as under hay and aftermath. When pasture cuts are taken to ground level, tiller and root development both show marked diminution.

(6) The effect of nitrogen applied in frequent heavy doses has been to increase tiller and root development under both systems of pasture cutting as well as under hay and aftermath. This effect as applied to roots had not shown itself under the influence of a single dressing of an inorganic nitrogenous manure.

(7) The continual plucking of inflorescences has given rise to a greater development of tillers and of roots than cutting as hay and aftermath. The actual number of inflorescences produced has also been greater under " plucking ". " Plucked " plants with nitrogen have given more inflorescences than plants similarly treated without nitrogen.

(8) It is to be emphasised that the results here brought together have been obtained on widely spaced individual plants grown on a fertile soil and that the nitrogenous dressings have been exceedingly heavy. It is not, therefore, to be assumed that

similar results would necessarily be obtained under ordinary sward conditions. The data presented are however a part, and an important part, of the general evidence being accumulated at the Station, and in a future paper will be further considered in the light of sward trials now in progress.

It is, however, legitimate to make reference to the presumable bearing of the present results on pasture practice in two important respects.

(*a*) The fact that plants cut to 6ins. have so considerably outyielded those cut to ground level in respect to gross yield throughout the season does seem to indicate that very close and continuous grazing can hardly be otherwise than detrimental to the continual productivity of swards so treated—and the more so since tiller and root development have been so much greater under the less drastic system of cutting.

(*b*) The fact that continuous plucking of inflorescences as they are exserted has tended to favour both tiller and root development would seem to add emphasis to the soundness of the practice of running pastures over with the mowing machine if and when inflorescences are produced to excess. The evidence would seem, however, to point to the desirability of bringing the mowing machine to bear on such pastures earlier in the season than is usual, and if necessary to repeat the operation.

Acknowledgements.

Thanks are due to Mr. I. G. Lewis, N.D.A., who assisted in the counts and weighings, and to Mr. J. W. Watkins, Farm Superintendent, for applying the manurial dressings in connection with the experiment.

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THE INFLUENCE OF DATE OF SOWING ON THE PERMANENCY OF CERTAIN LEGUMES AS CONSTITUENTS OF PASTURES.

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The experiment discussed in this paper was designed primarily to test the influence of sowing date on the over-wintering capabilities of certain species and strains of legumes.

It is a significant fact that some species of legumes as self established plants contribute in fair quantity to pastures and hay independently of being included in seeds mixtures, and yet when sown they form only a negligible amount of the herbage after the seeding year, at all events for some years.

Previous work at the Welsh Plant Breeding Station with subterranean clover (see Williams and Davies (1) and Davies (2))[1] clearly indicated that if this species was to become a permanent element in any pasture attention would have to be given to time of sowing. It seemed probable therefore that date of sowing, especially in the case of annual legumes, was a far more important factor than had been supposed. For this reason a further test was carried out, using various strains of yellow suckling clover with subterranean clover as a check; while for comparison with perennials two birdsfoot trefoils (*Lotus major* and *L. corniculatus*) were also brought into the trial, since these two species had not been previously tested at the Station.

Material and methods.

The species and strains under test were sown in drills 4 feet long and 18 ins. apart at the rate of six viable seeds per linear inch. Sowings were made to cover a period of fifteen months commencing on June 1st, 1927. In most cases there were five replications of each strain at each sowing date, and for the greater part of the year sowings were made approximately at fortnightly intervals. During the winter the sowings were made at longer intervals than during the normal growing season. In regard to the sowings of 1927, counts of plants were made and dry green weights of cuts were taken in July, 1928, a similar procedure for 1928 sowings being carried out in October, 1928.

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[1] References to literature: see list at the end of the article.

Discussion of results: establishment in the first harvest year.

In this and subsequent sections the data from the two species of birdsfoot trefoil can be quite legitimately averaged as both behaved in a precisely similar manner.

The figures in Table I give the results for establishment into the first harvest year (1928) in the case of sowings made at the different dates in 1927.

TABLE I.

Showing per cent. establishment in July, 1928, for sowings made at various dates from June 1st to December 1st, 1927: average of three replications.

Species.	*Date of sowing 1927.*			
	1/6	*16/6*	*1/7*	*16/7*
Yellow suckling clover (average of eight strains)	Trace	Trace	1.2	9.7
Birdsfoot trefoil (average of four strains)	33.1	22.7	14.0	10.6
Subterranean clover (one strain) ...	Nil.	Nil.	3.5	22.5

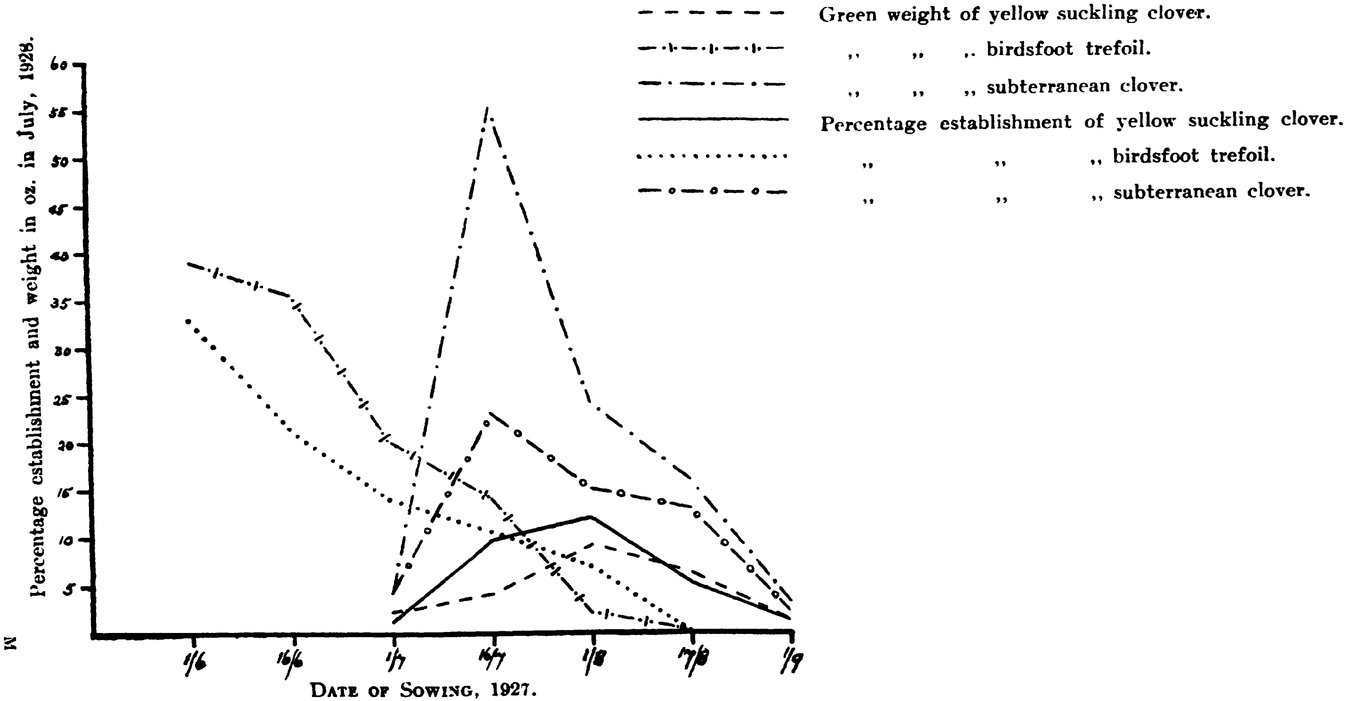
Species.	*Date of sowing 1927.*			
	1/8	*17/8*	*1/9*	*16/9*
Yellow suckling clover (average of eight strains)	11.8	5.0	1.4	Trace
Birdsfoot trefoil (average of four strains)	6.9	0.5	0.1	Nil.
Subterranean clover (one strain) ...	15.1	13.6	1.5	0.8

An examination of the figures in Table I shows that the optimum date of sowing varies even during the same season, and it is fair to assume that the most successful date of sowing of these species as an average over a number of years would probably lie within a period a fortnight earlier or later than the best date in 1927.

The optimum date for yellow suckling clover was at least eight weeks later than that for birdsfoot trefoil and about two weeks later than that for subteranneau clover. The figures for yellow suckling in particular are very low, but all the strains of this species behaved in a similar manner. It is justifiable therefore in the light of the figures to state that the optimum date of sowing in

FIG. 1.

Showing relationship between per cent. establishment of viable seed in first harvest year (1928) and weight of herbage per drill in ozs. on July 18th of that year (1928) for sowings made at various dates in 1927.



1927 lay somewhere near August 1st and that sowings made prior to July and after August 17th were a distinct failure in so far as persistency into the first harvest year is concerned.

In regard to birdsfoot trefoil the figures represent the average of four strains and show that the best period of sowing lies at or about June 1st or prior to that date. Later sowings show a pronounced falling off in establishment and sowings made after July 16th may be regarded as not only uneconomical but a distinct failure. Unfortunately in this trial no data are available for first harvest year establishment for sowings before June 1st. There is, however, evidence from field trials now in their fourth harvest year that indicate that birdsfoot trefoil can be successfully established from sowings made in May. It is thus seen that birdsfoot trefoil, like other perennial species previously tested (see Stapledon, Davies and Beddows (3)) would seem to succeed best from sowings made not later than about the middle of June.

Yield in relation to establishment.

The relationship between yield and establishment in the first harvest year are shown in Fig. 1.

It is seen from Fig 1 that in the case of all three species there is a distinct linkage between first harvest year yields and per cent. establishment. The date of sowing in 1927 which gives the highest per cent. establishment in July, 1928, also provides the largest quantity of herbage during that month. On account of the negligible amount of herbage, no weights were taken for sowings made on September 16th, October 3rd, November 1st and December 1st, 1927.

Establishment in the seeding year.

Average results for establishment in the seeding year are given in Table II in respect of sowings made in 1928 for the species under review.

TABLE II.

Showing actual number of plants per 4 ft. drill in October, 1928, for sowings made on certain dates from February 7th to September 1st in the same (seeding) year. Average of five replications.

Species.	*Date of sowing 1928.*			
	7/2	*1/3*	*16/3*	*2/4*
Yellow suckling clover (average of all strains) ...	18.3	14.8	26.6	30.2
Birdsfoot trefoil (average of all strains) ...	5.7	47.6	62.3	67.8
Subterranean clover ...	7.2	7.4	11.7	11.7

TABLE II.—Continued.

Species.	*Date of sowing 1928.*			
	16/4	*1/5*	*1/6*	*11/7*
Yellow suckling clover (average of all strains) ...	47.6	51.7	50.5	69.6
Birdsfoot trefoil (average of all strains) ...	99.2	75.0	75.8	108.7
Subterranean clover ...	41.3	73.0	54.0	57.3

Species.	*Date of sowing 1928.*	
	2/8	*1/9*
Yellow suckling clover (average of all strains) ...	50.8	25.5
Birdsfoot trefoil (average of all strains) ...	69.0	18.3
Subterranean clover ...	66.0	46.0

The figures in Table II differ from those in Table I since they do not supply information in relation to over wintering. They show, however, that even clovers have a fairly wide range of sowing dates for successful seeding year establishment. Unfortunately some of the very early sowings were allowed to re-seed before it was convenient to make counts, and for this reason actual numbers of plants rather than per cent. establishment are given.

Yields in the seeding year.

Yield data for the seeding year from sowings made in 1928 are given in Table III.

TABLE III.

Showing actual weight of herbage in oz. per 4 ft. drill on October 12th for sowings made during period March 1st to July 11th, 1928. Average of five replications.

Species.	*Date of sowing 1928.*			
	1/3	*16/3*	*2/4*	*16/4*
Yellow suckling clover (average of all strains) ...	5.8	10.9	10.6	18.8
Birdsfoot trefoil (average of all strains) ...	10.1	15.6	10.8	16.0
Subterranean clover ...	3.7	15.7	39.7	59.8

TABLE III.—Continued.

Species.	*Date of sowing 1928.*		
	1/5	*1/6*	*11/7*
Yellow suckling clover (average of all strains) ...	13.2	10.6	Trace
Birdsfoot trefoil (average of all strains) ...	9.0	7.1	0.6
Subterranean clover ...	71.4	39.3	12.5

The figures presented in Table III show that for seeding year yields date of sowing is not such an important factor and that sowings made from March 16th to June 1st will contribute in fair quantity in October. For the provision of autumn bite in the seeding year, therefore, clovers, and especially annual clovers, have a wider range of sowing dates than when the plants are intended for overwintering.

The economic significance of the results as a whole.

The results presented in this paper are of distinct importance in Wales. They help to some extent to explain why some species, although sown, do not make any appearance in the sward after the first year. The indications are that some species of legumes are very sensitive to date of sowing especially if intended to contribute to the herbage for more than one year. The data here considered together with results previously obtained at the Station render it quite evident that this applies particularly to annuals which, in order to perpetuate themselves, have to depend on favourable conditions for re-seeding.

The case of yellow suckling clover is of particular interest for this is a species which is very prevalent as a natural endemic plant in Welsh pastures and gives a very appreciable amount of palatable herbage much relished by sheep late in the season. Professor Stapledon has informed the present writer that when he first came to Wales he was so impressed with yellow suckling clover as an ingredient on relatively poor swards that he included the seed in a large number of experimental mixtures but never got tangible results from so including it. These mixtures were of course sown under corn in the ordinary way, that is to say, much too early for suckling clover. Sown at the optimum date, which would appear to be July or August, this clover behaves like subterranean clover and establishes itself as a winter annual and does not flower and set seed until the following spring

—sown earlier it comes into flower in the seeding year, but either has not time to set good seed or if a little seed is set the young seedlings which establish themselves late in the autumn are winter-killed. The original plants having flowered die during the winter, and thus no plants of this clover will have been established into the first harvest year as the result of the sowing.

The behaviour of both yellow suckling clover and subterranean clover is of considerable importance in connection with the method of ploughing very poor pastures and immediately reseeding on the upturned sod. It has been previously shown that the rye-grasses succeed quite well from sowings made as late as July and August, while cocksfoot may succeed fairly well. In the case of such fields not ploughed in time for sowing in April or May and if sowing be deferred until July or August both suckling clover and subterranean clover[2] should prove very valuable ingredients in the seeds mixture, which would naturally be sown out with rape as the nurse crop.

Since ploughing and re-seeding has shown itself to be such an excellent means of improving poor grassland it would be of considerable value if a longer period were available for conducting the necessary operations— and thoroughly satisfactory mixtures could be devised for sowing out in Wales as late as August.

The evidence relative to the birdsfoot trefoils is of interest, for although these species are at present not largely used in seeds mixtures, trials now in progress at the Station indicate that certain strains in particular are likely to prove very valuable for inclusion in mixtures on poor and hilly land. The evidence suggests that this species can be sown with ordinary mixtures at normal dates, though probably May would be preferable to April, and the indications are that the seed rates should be heavy.

Summary.

(1) The effect of sowing date on yield and establishment in the seeding and first harvest years has been discussed in the case of yellow suckling clover, subterranean clover and the perennial birdsfoot trefoils.

(2) The range of sowing dates for successful overwintering for the legumes under test is very limited.

(3) The optimum sowing date for the annuals, yellow suckling clover and subterranean clover, was much later than for the perennial birdsfoot trefoils.

(4) Early sowings of yellow suckling and subterranean clovers

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[2] Subterranean clover should not, however, be employed on exposed fields or in districts with severe winters (see Stapledon and Thomas (4).)

do not permit of successful overwintering, while the sowing of the birdsfoot trefoils after June does not produce a stand in the first harvest year.

Acknowledgement.

I beg to express my gratitude to Professor R. G. Stapledon, M.A., for his helpful interest and advice, and to Mr. William Davies, M.Sc., for his guidance during the progress of the experiment. I am indebted also to Mr. J. W. Watkins, Superintendent of the Farm and Gardens, who supervised all the sowings, and to Mr. T. E. Jones, N.D.A., for invaluable assistance in connection with the collection of the data.

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THE EFFECT OF CUTTING TO THE GROUND LEVEL UPON THE GROWTH OF ESTABLISHED PLANTS OF *DACTYLIS GLOMERATA* AND *PHLEUM PRATENSE*.

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Introduction.

The after-effect of grazing upon a potential hay field constitutes one of the problems of grassland management that has recently received attention by the workers of the Welsh Plant Breeding Station. The effect of the date to which grazing is continued upon the subsequent growth of the several species contributing to the hay crop has been studied by Stapledon (6)[1] and Stapledon and Davies (7). These workers have shown that results in general agreement with those obtained by sheep-grazing can be produced by cutting with garden mowing machines and shears. They studied the competitive factor of plant against plant of the same or differing species in relation to the effect of the grazing treatment, and found, for example, that the usual shading effect of Italian rye-grass could be reduced to a minimum by regulated spring grazing. The differential effect of the grazing upon the various strains and species was well illustrated by the later, slower-growing species, which presumably in consequence of their habit suffered most by this treatment.

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[1] Reference by number is to " Literature Cited ", p. 197.

In the course of another investigation bearing upon the effect of curtailed daily periods of natural illumination on the growth and habits of several species of grasses (11), data have been collected which, when analysed, show the effect of cutting upon the growth of these grasses. Somewhat similar data have been collected by other members of the Station staff working with other species. The present results, though of no great significance in themselves, are reported so that their relationship to the general agronomic problems, to which reference has been made, may be studied in conjunction with other work.

I. Outline of methods.

The grasses here employed were as follows :—

Cocksfoot a late indigenous type, 828 Bc.
—a hairy Danish type, 833 Bc.
—a dense tussock type, 914 Bc.
Timothy—two series of a late indigenous type, Bd. 95.

The requisite number of plants was obtained by repeated vegetative propagation. Propagants were grown for three years from single tillers, these large plants were divided into quarters and grown in separate pots. There were, therefore, four replications available. At the commencement of the season—February 2nd—the whole series of plants were clipped to the soil level by means of large scissors, and subsequently at different dates. The scheme of cutting employed was such that at four weekly intervals some plants were cut for the first time since February, together with others which had been previously cut. By this means it was possible to synthesise a general growth curve for the season, and to compare the behaviour of the clipped plants with a series of growth indices. Such a comparison, within a given strain, has not previously been made. The cuttings were estimated by weight after separation into leaf-blade, sheath, stem and panicles (if any), followed by drying at 85° C. in an oven.

TABLE I.

The effect of clipping on the dry weight accumulated as "top growth" by late indigenous cocksfoot plants.

Date of cutting.	*Average total dry weight of top growth per plant to date (gm.)*					
	Group numbers.—References.					
	(9)	*(12)*	*(14)*	*(16)*	*(17)*	*(19)*
Feb. 2	3.36	3.36	3.36	3.36	3.36	3.36
Mar. 3	3.82	5.25	-	—	—	—
Mar. 31	4.90	6.67	5.70	—	—	—
Apr. 28	—	8.54	7.34	17.62	—	—
May 26	—	—	9.74	22.56	20.80	—
June 23	—		—	27.03	24.51	33.56
July 21	—	—	—	30.83	27.36	36.56
Aug. 18	—	—	—	—	—	39.07

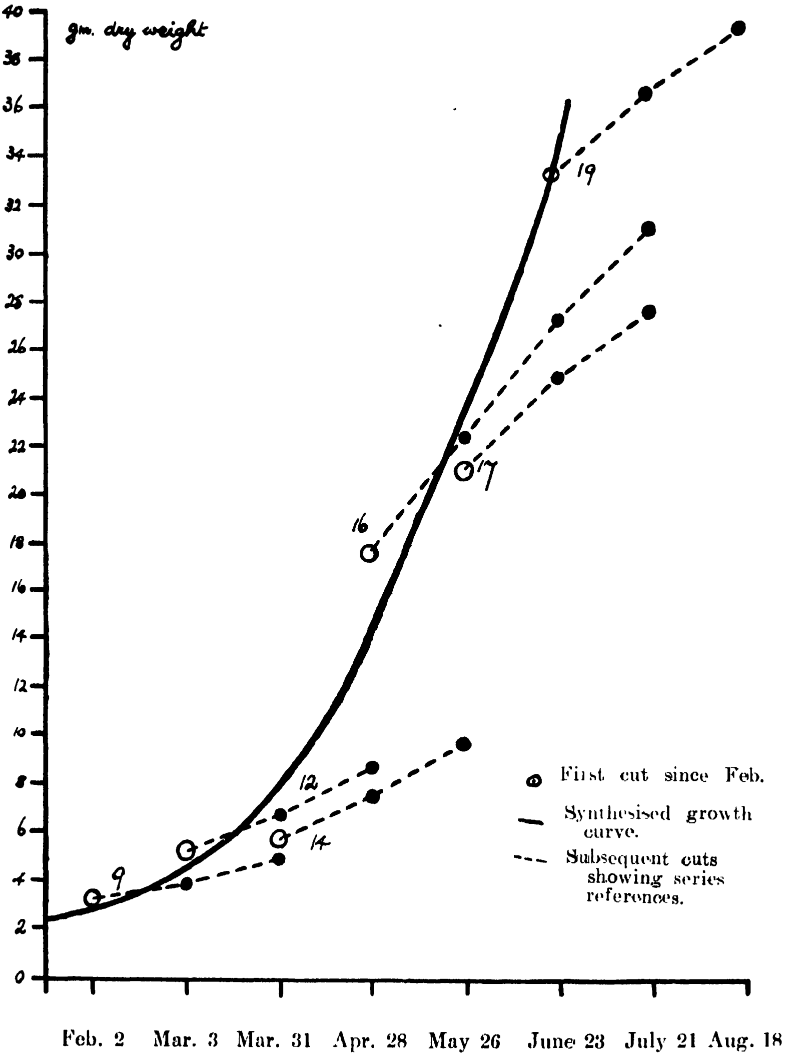
II. Effect of cutting upon dry weight accumulation.

The dry weights obtained from each plant are indicated in Graph I (from the data of Table I)—it is seen that the increase made per month is reduced by clipping—especially is this the case in the warmer months. This signifies that the plant produces more additional dry weight in a month by adding to its old growth than when it is clipped and produces new leaves. This may be expected; the removal of the leaves reduces the area for photosynthetic activity. In cocksfoot the rate of formation of the new leaves is not sufficiently high to allow the plant to recover its original rate of carbohydrate assimilation. The increase per month in the case of both the clipped and the unclipped plants is greater in the warmer months than at the beginning of the season.

The data obtained from a series of Danish open type of cocksfoot and for a particularly late indigenous tussock type are presented in tabular form in Table II. In the Danish type it is seen that at the beginning of the season the clipped plants have not produced so much dry weight (compare the clipped (3.63) with unclipped (8.22) in April), but later on in the season the clipped plants have yielded practically as well as the unclipped series. Clipping was carried out at intervals of eight weeks: with such treatment it seems possible to obtain a mass of young herbage equal to that which would be obtained, but of older herbage, without clipping. The figures for the tussock series indicate that plants cut monthly do not produce as much dry weight as uncut plants.

GRAPH 1.

Dry weight accumulation in late indigenous cocksfoot (828 Bc.) 1925.



The results obtained from two series of timothy plants are shown in Table III. Briefly, these figures indicate that plants cut at intervals of eight weeks do not produce as much dry weight as do plants not previously cut.

In summarising this section it can be stated that cutting at monthly intervals reduces the yield obtained in the case of the following types—indigenous cocksfoot, late indigenous cocksfoot, tussock type, and late indigenous timothy. In the case of Danish

TABLE II.

The effect of clipping on the dry weight accumulated as "top growth" by Danish open and tussock cocksfoot.

Date of cutting.	*Average total dry weight of top growth per plant to date (gm.).*		
	Group numbers.—References.		
	(13)	*(27)*	*(31)*
	Danish types.		
Feb. 2	2.30	—	—
Mar. 3	2.78	—	—
Mar. 31	3.63	8.22	—
Apr. 28		—	12.55
May 26	—	21.82	—
June 23	—	—	23.01
July 21	—	26.82	—
Aug. 18	—	—	27.88

Date of cutting.	*Average total dry weight of top growth per plant to date (gm.).*				
	Group numbers.—References.				
	(3)	*(4)*	*(7)*	*(8)*	*(13)*
	Tussock types.				
Feb. 2	4.19	—	—	—	—
Mar. 3	4.89	3.10	—	—	—
Mar. 31	5.69	4.67	—	—	—
Apr. 28	—	6.95	8.35	—	—
May 26	—	—	11.62	—	—
June 23	—	—	14.84	22.33	—
July 21	—	—	—	25.23	—
Aug. 18	—	—	—	27.58	26.10

open cocksfoot, plants cut at intervals of eight weeks yield practically as much as plants cut at longer intervals.

III. Effect of cutting upon the quality of the growth.

(*a*) *Leaf/stem ratios.*

Normal grass plants show seasonal variation in the ratio of leaf-sheath and stem to leaf-blade. It has been shown by Fagan, (3) and (4), and others that the chemical composition of the leaf-sheath closely resembles that of the stem. The leaf-blade is more nutritious, being richer in nitrogenous compounds and soluble carbohydrates and less fibrous than the sheath. For this and other reasons it has been customary to divide the top growth

TABLE III.

The effect of clipping upon the dry weight accumulated as " top growth " by two series of late indigenous *Phleum pratense*.

Date of cutting.	*Average total dry weight of top growth per plant to date (gm.).*			
	Group numbers.–References.			
	(*1*)	(*2*)	(*3*)	(*4*)
	" *A* " *Series.*			
Feb. 2	3.20	—	—	—
Mar. 3	—	—	—	—
Mar. 81	4.95	5.6	—	—
Apr. 28	—	—	—	—
May 26	11.50	9.6	11.20	—
June 23	—	—	—	—
July 7	—	16.55	20.4	22.75
Aug. 18	—	—	—	—

Date of cutting.	*Average total dry weight of top growth per plant to date (gm.).*			
	Group numbers.–References.			
	(*1*)	(*2*)	(*3*)	(*4*)
	" *B* " *Series.*			
Feb. 2	—	—	—	—
Mar. 3	5.28	—	—	—
Mar. 81	—	—	—	—
Apr. 28	8.92	10.92	—	—
May 26	—	—	—	—
June 23	16.16	21.67	23.25	—
July 7	—	—	—	—
Aug. 18	—	—	28.42	30.11

in the two classes, " leaf " signifying leaf lamina, and " stem " including leaf-sheath (see Stapledon (7)); all dry brown leaves or sheaths being estimated in a separate category—that is, " burn ". The variation in the ratio leaf/stem then serves as an index not only of the morphological nature of the growth but also of its nutritional value. The effect of clipping upon this ratio is shown in the following Tables.

It is seen from Tables IV and V that frequent clipping prevents " stem " formation—it reduces the amount of sheath produced; the new growth consists chiefly of leaf-lamina and is highly nutritious. The ratio leaf/stem falls to its lowest at the

TABLE IV.

To show the effect of clipping upon the leaf/stem ratio.

Dates of cutting.	*Leaf/Stem ratios.*							
	Late indigenous cocksfoot.							
	Group numbers.—References.							
	(9)	*(12)*	*(14)*	*(16)*	*(17)*	*(19)*	*(23)*	*(31)*
Feb. 2	cut	cut	cut	cut	cut	cut	cut	cut
Mar. 3	4.6	3.5	—	—	—	—	—	—
Mar. 31	10.2	6.0	3.6	—	—	—	—	—
Apr. 28	—	12.1	8.7	2.37	—	—		—
May 26	—	—	2.2	1.28	.89	—	—	—
June 23	—	—	—	4.5	3.6	.2	—	—
July 21	—	—	—	4.6	4.7	4.9	.7	—
Aug. 18	—	—	—	—	—	7.5	4.3	1.8

Dates of cutting.	*Leaf/Stem ratios.*				
	Danish open cocksfoot.				
	Group numbers.—References.				
	(13)	*(27)*	*(31)*	*(33)*	*(34)*
Feb. 2	cut	cut	cut	cut	cut
Mar. 3	cut	—	—	—	—
Mar. 31	5.2	3.1	—	—	—
Apr. 28	—	—	2.36	—	—
May 26	—	.29	—	—	—
June 23	—	—	.41	—	—
July 21	—	2.9	—	3.3	—
Aug. 18	—	—	3.10	—	2.65

TABLE V.

To show the effect of clipping upon the leaf/stem ratio.

Dates of cutting.	*Leaf/Stem ratios.*				
	Tussock cocksfoot.				
	Group numbers.—References.				
	(3)	*(4)*	*(7)*	*(8)*	*(13)*
Feb. 2	cut	cut	cut	cut	cut
Mar. 3	cut	17.9	—	—	—
Mar. 31	4.6	—	—	—	—
Apr. 28	—	24.3	20.8	—	—
May 26	—	12.2	17.7	—	—
June 23	—	—	4.75	.41	—
July 21	—	—	—	3.50	—
Aug. 18	—	—	—	.60	4.2

TABLE V.—Continued.

Dates of cutting.	*Leaf/Stem ratios.*							
	Late indigenous timothy.							
	" A " Series.				*" B " Series.*			
	Group numbers.—References.							
	(*1*)	(*2*)	(*3*)	(*4*)	(*1*)	(*2*)	(*3*)	(*4*)
Feb. 2	cut	cut	cut	cut	cut	cut	cut	cut
Mar. 3	cut	—	—	—	3.3	—	—	—
Mar. 31	4.0	2.2	—	—	—	—	—	—
Apr. 28	—	—	—	—	4.1	1.99	—	—
May 26	1.6	1.99	1.51	—	—	—	—	—
June 23	—	—	—	—	1.19	1.02	.78	—
July 21	—	.92	1.56	.44	—	—	—	—
Aug. 18	—	—	—	—	—	—	3.4	.22

TABLE VI.

To show the dry matter content of leaf blades.

Dates of cutting.	*Per cent. dry matter in leaf laminae.*		
	Hairy Danish cocksfoot.		
	Group numbers.—References.		
	(*13*)	(*27*)	(*31*)
Feb. 2	30.5	—	—
Mar. 3	20.6	—	—
Mar. 31	23.4	29.1	—
Apr. 28	—	—	29.2
May 26	—	23.5	—
June 23	—	—	30.3
July 21	—	28.8	—
Aug. 18	—	—	32.2

Dates of cutting.	*Per cent. dry matter in leaf laminae.*				
	Tussock cocksfoot.				
	Group numbers.—References.				
	(*3*)	(*4*)	(*7*)	(*8*)	(*13*)
Feb. 2	28.2	—	—	—	—
Mar. 3	17.2	—	—	—	—
Mar. 31	21.0	27.4	—	—	—
Apr. 28	—	26.0	25.4	—	—
May 26	—	18.5	20.4	—	—
June 23	—	—	18.4	32.5	—
July 21	—	—	—	22.1	—
Aug. 18	—	—	—	22.2	27.1

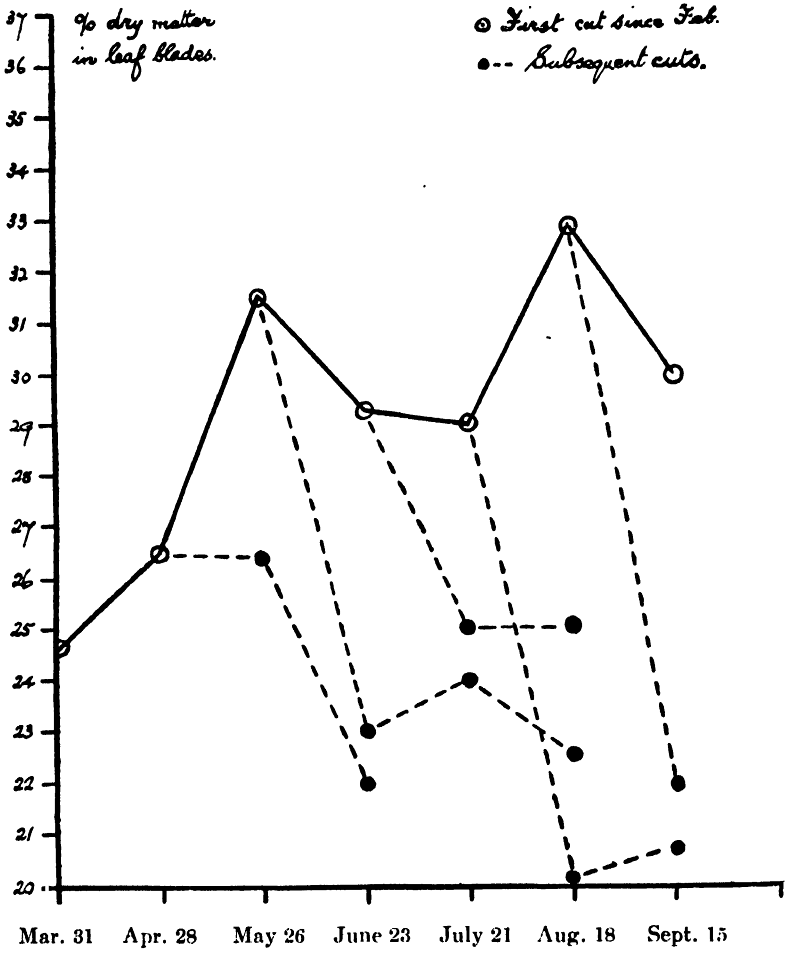
time of flowering, this naturally occurs later in the case of the timothy than in the cocksfoot series.

(*b*) *The moisture content of the leaf tissues.*

The plants were watered at intervals of two days and received in addition the natural rainfall; there was, therefore, no suggestion of any water shortage. After cutting, the new leaves appeared, in all cases, quickly. In Graphs 2 and 3 the dry matter content of the leaves of late indigenous cocksfoot and late indigenous timothy is shown throughout the season. The seasonal fluctuation in *dry* matter content in plants uncut since February

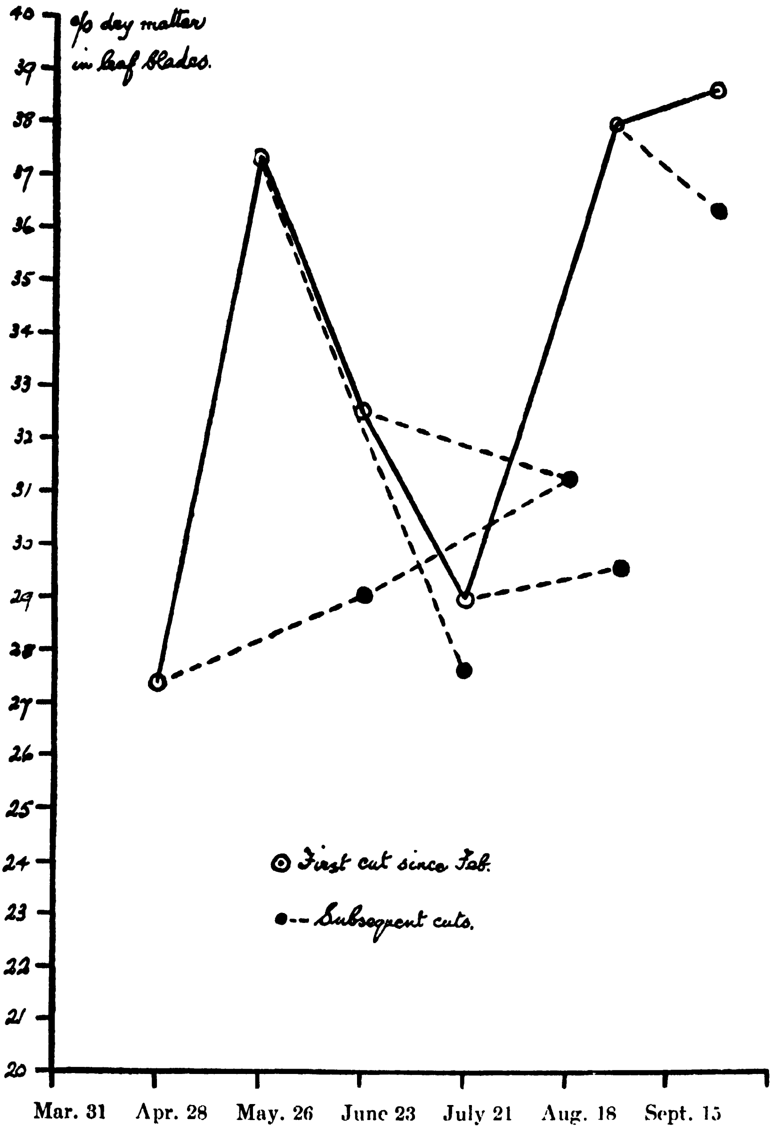
GRAPH 2.

Effect of clipping on dry matter content of leaves of late indigenous cocksfoot.



GRAPH 3.

Effect of clipping on dry matter content of leaf blades of late indigenous timothy.



shows a general direct *agreement* with the rainfall fluctuation. The reason for this is somewhat obscure, and particularly so when it is remembered that the roots of the plants always enjoyed moist conditions. One point is, however, clear; the moisture content of the leaves has *not* been dependent upon the rainfall. The graphs show clearly that the newly formed leaves contain much less dry matter than the older leaves. The data for the tussock and open Danish types are presented in Table VI. The decrease in the dry matter content of the slow growing tussock type when cut is larger than in the case of the other grasses; the more rapidly growing Danish open type recovers and apparently its leaves mature so that in eight weeks the dry matter content of the leaves approaches again that of uncut plants. It has been shown by Fagan (3) and others (11) that the young leaves of the grasses are particularly rich in protein and are relatively less fibrous than the older leaves. The clipping treatment (or grazing in so far as it is portrayed truly by clipping) produces for the animal further fresh herbage of a high moisture content, fairly rich in protein, and relatively poor in fibre.

The dry "burnt-up" leaves and leaf-sheaths have not been included in these determinations of moisture content. The cut plants produce very small quantities of such growth in comparison with the uncut. This again tends to make the herbage more palatable to stock. It has been demonstrated that the relative amount of "stem" (leaf-sheath and stem) is reduced by clipping. Moreover, a similar effect to that just described for the leaf-blade is observed in the stem also. The newly formed "stem" contains less dry matter. Chemical analysis reveals the fact that although it is very much poorer in nitrogenous compounds than the leaf, the young "stem" is less fibrous and contains more nitrogen than does the older growth. On all these counts, therefore, the young herbage obtained after cutting would seem to be highly attractive to the grazing animal.

IV. The effect of cutting upon flowering and seed production.

The effect of clipping upon the flower production of the different series is shown in Table VII. Briefly, it is observed that the early Danish open type flowered but a few days later despite the fact that it was cut in February and at the beginning of March. The panicles produced were quite tall. Plants cut in February and at the beginning and end of March also produced panicles by the end of May. Even when cut as late as the end of April this type of cocksfoot produced panicles at the end of June, about three weeks later than those plants cut only in February.

The late indigenous series were able to flower if cut in February and at the beginning and end of March. Other series cut four times at monthly intervals from the beginning of February to the end of April produced short panicles at the end of June. Plants cut as late as May did not flower. Plants cut only in February were earlier and taller.

The tussock series gave somewhat similar results, but flowering was practically prevented by cutting at the end of April.

The general behaviour of the later flowering species—timothy—confirmed the cocksfoot results. By cutting in February and at the end of March and again in May, flowering was retarded by approximately fourteen days and shorter inflorescence stalks were obtained. Plants cut in June did not flower.

TABLE VII.

To show the effect of clipping upon panicle formation and elongation of panicle stems in cocksfoot and timothy.

Series.	*Plant numbers. References.*	*Dates of cutting.*	*Dates of maximum pollen. Flowering zenith.*	*Height to panicle at zenith (pollen) inches.*
Danish open cocksfoot.	H.13.	Feb. 2 Mar. 3	June 12—pollen.	35—June 12
	H.27.	Feb. 2 Mar. 3 May 26	May 28—panicles emerging when cut.	17—May 26 when cut.
	H.31.	Feb. 2 Apr. 28 June 23	June 22— panicles open.	30—when cut.
	H.33.	Feb. 2 July 21	June 8.	35.
Late indigenous cocksfoot.	L. 9.	Feb. 2 Mar. 3 Mar. 31	June 22.	22.
	L.12	Feb. 2 Mar. 3 Mar. 31 Apr. 28	June 24.	16
	L.14.	Feb. 2 Apr. 28 May 26 June 23	did not flower.	—
	L.16-30.	Later cut plants.	did not flower.	—
	L.31 etc.	Feb. 2 only—controls.	June 16.	29.
Tussock cocksfoot.	T. 3.	Feb. 2 Mar. 3 Mar. 31	June 19.	24
	T. 4.	Feb. 2 Mar. 3 Mar. 31 Apr. 28	one panicle only.	4—stem.
	T. 7 etc.	Feb. 2 Apr. 28 May 26 June 23	no panicles.	no stem.
	T. 8 etc.	Feb. 2 only—controls.	June 22—24.	22—24.

TABLE VII.—Continued.

Series.	*Plant numbers References.*	*Dates of cutting.*	*Dates of maximum pollen. Flowering zenith.*	*Height to panicle at zenith (pollen). inches.*
Late indigenous timothy.	A. 1.	Feb. 2 Mar. 31 May 26	August 14.	19.
	B. 1.	Feb. 2	did not flower but produced some stem on June 23.	
		Mar. 3 Apr. 28 June 23		7—on June 23.
	A. 2.	Feb. 2 Mar. 31 May 26 July 21	never produced more than 3 in. stem.	
	B. 2 etc.	Later cut plants.	never produced more than 3 in. stem.	
	C.	Feb. 2 only—controls.	July 28 to Aug. 2.	21.

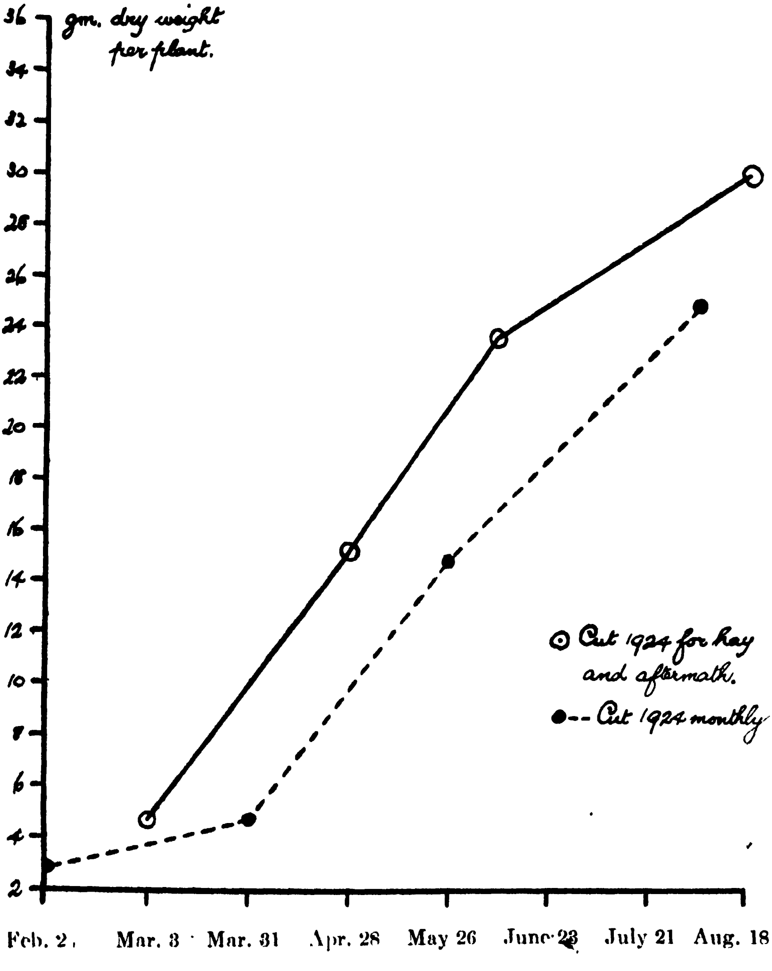
In general it is seen that early cutting delays flowering and causes shorter panicle stalks. Cutting at a later date prevents flower production entirely. It would seem probable that the flower primordia are laid down in mid-April in the case of the cocksfoot plants grown under such conditions. Plants cut after this date would lose the primordia in the ensheathing leaves. It is to be noticed that plants cut after this date do not flower because presumably the plants do not form further flower primordia. Other experiments (11) have shown that a reduction of the period of natural illumination prevents flower production probably because the ratio carbohydrate/nitrogen does not become sufficiently high. The delay in flowering observed as the result of clipping is similarly explained, the clipping makes the plant poor in carbohydrates (and removes " potential " carbohydrate). It is thought that even were a second series of primordia laid down flowering would not take place so late as autumn, when the naturally short days would prevent stem elongation and panicle-exsertion. Cocksfoot plants with late formed primordia have been found to omit the seasonal production of panicles and to flower in the next season (see (10)) when the period of daylight was sufficiently long. It is suggested that the early Danish variety by its more rapid general metabolism recovers and so reaches the necessary ratio carbohydrate/nitrogen at an earlier date than does the dense Tussock type. The results obtained by cutting are then in agreement with those, reported elsewhere, obtained by artificially reducing the period of daylight.

V. An illustration of the predetermining effects of one season's treatment upon subsequent growth.

For this experiment two series of timothy, vegetative propagants of one parent plant, were employed. In 1924 one series, A, was cut monthly. The other series, B, was cut twice :—for hay and aftermath. During 1925 these plants were treated in the same manner. In Graph 4 the accumulation of dry weight is

GRAPH 4.

Pretreatment effects shown by timothy plants during 1925 (cut differentially 1924) by synthesised curves from many plants.



shown for the two series. It is seen that the B series (1924 cut twice) produces more dry weight than the A series (1924 cut monthly), so that there is a lasting effect produced by the treatment of the previous season which thus predetermines the subsequent seasonal growth. A similar result was obtained from four further series of cocksfoot and timothy which were subject to curtailed daily illumination: the plants previously clipped at monthly intervals did not yield so well as others which were only cut twice in the previous season.

VI. Discussion.

In considering the results presented, attention is drawn to the more extensive trials by other workers.

The deleterious effect of clipping upon the total bulk produced was observed by Crozier (1), who also worked with cocksfoot. Stapledon (6) in his extensive study has pointed out that permanent grass, temporary leys and pure colonies of plants raised from tillers all show that the aggregate produce of a series of " pasture cuts " do not equal the produce obtained by one hay cut. His results also show that with many species the more frequent the cutting the greater is the decrease of total yield. The results here presented are in agreement with such work. The investigations of Lindhard (5) with permanent grass and of Ellet and Carrier (2) with permanent blue grass pastures are in agreement with the cocksfoot results. The data collected upon the quality of the growth made, as shown by the leaf/stem ratio, are also in agreement with the results of Stapledon (6), who showed that many pasture cuts favour leaf formation and that the percentage of leaf is at its lowest in samples uncut till hay time. The inherent periodicity of the plants is shown by the production of elongated leaf-sheaths (see Table VII) by, for example, tussock cocksfoot previously cut in March and April. Although no panicles may emerge the preliminaries usually associated with the production of flowers may be carried out. This tendency of the plant towards stem formation has been discussed in conjunction with meteorological conditions by Stapledon; in the experiments here reported this cannot be done with any advantage, as artificial watering masked entirely the rainfall effect. The moisture determinations showing that the young leaves are less rich in dry matter are in agreement with earlier work, such as that of Sutton and Voelcker (9) upon the dry matter content of hay cut at various dates.

Summary.

1. The effect of cutting upon the total produce obtained

during the growing season from pot cultures of vegetative propagants has been shown to be a reduction in the total dry weight obtained in the case of cocksfoot and timothy.

2. The new growth obtained after cutting contains a high percentage of " leaf ". The moisture content is high.

3. Plants subjected to such cutting treatment either flower late or omit entirely the seasonal flower production. These results have been briefly considered from the carbon/nitrogen ratio standpoint.

4. The effect of the method of cutting carried out during one season upon the subsequent seasonal growth has been traced with timothy.

5. The results are in close agreement with previous work at the Welsh Plant Breeding Station.

Acknowledgments.

I am indebted to Professor R. G. Stapledon for his interest and help, so readily given on all occasions, and desire to thank also Mr. T. J. Jenkin, M.Sc., for provision of the timothy plants, and for some data which he has kindly placed at my disposal.

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A COMPARATIVE STUDY OF THE EFFECTS OF ARTIFICIAL MANURES ON THE BOTANICAL COMPOSITION OF THE HERBAGE IN AN OLD PASTURE.

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Introduction.

The improvement of grassland has for many years been the subject of a large number of experiments and investigations throughout the country, with the result that considerable valuable information has been collected on the matter.

The annual increase in the area of land under grass in late years has resulted in the British farmer becoming more and more dependent on the productivity of grassland for his livelihood, and has stimulated interest in the improvement of pastures and meadows. The superior feeding value of the leaf over the stem of grasses has been well demonstrated by several workers, and emphasises the importance of efficient management of pastures.

It has also been proved that manuring has considerable influence on the chemical composition of grasses, and that certain grass species have a higher feeding value than others.

In view of these facts there is no doubt that a study of the effect of manuring on the botanical composition of various grass land types offers a fruitful yield of investigation to the botanist, and that extensive work in this direction coupled with the co-operation and co-ordination of the chemist would help considerably towards finding a satisfactory solution of the many problems connected with pasture improvements.

Particulars of the trial.

The present article gives a brief account of the results of an experiment laid down at Madryn Farm School in March, 1923, with the view of comparing the effects of various artificial manures on the herbage in an old pasture.

The trial was put down on a level and uniform portion of a 22 acre pasture field known locally as the Deer Park. The field had been under grass for over fifty years, and had not received any manurial dressing for at least ten years previous to 1928.

The soil on this field is a light sandy loam overlying gravel. When tested at the commencement of the experiment it was found to be very deficient in lime, being low in exchangeable calcium, .083 per cent and having a pH figure of 4.85.

Four plots, each a quarter of an acre in area, were respectively dressed with Superphosphate 35 per cent., Basic Slag 27 per cent., Gafsa Phosphate 56 per cent., and Nauru Phosphate 84 per cent., at the rate of 200 lbs. P_2O_5 per acre, such a dressing being equivalent to 13 cwts. per acre of 30 per cent. Basic Slag.

Portions of the plots also received cross-dressings of Kainit 12½ per cent. at 4 cwts. per acre, and Ground Limestone 98 per cent. $CaCO_3$ at 2½ tons per acre.

A further plot of half an acre received Ground Limestone only at the same rate as above, and an additional area of quarter of an acre was left untreated to serve as a Control.

The main object in view was to compare the effects of the comparatively new phosphatic manures Gafsa and Nauru with those of standard phosphates like Slag and Superphosphate. The extension of the trial to include potash and lime applications would, it was thought, on account of the sandy nature of the soil and its acid character, provide valuable data as to the best method of treating such land in subsequent years.

As a rule in trials of this nature conducted in the county the conclusions drawn are based solely on the observations made in the field, such as the appearance of the swards, and the manner in which each plot is grazed by stock.

In the case of this trial however it was deemed advisable to obtain more exact information, and to this end a botanical analysis of the herbage on each plot was undertaken in the springs of 1924 and 1925. The results from the limed plots in these two years were so striking that it was considered advisable to analyse these again in 1927.

Method of analysis.

For each analysis ten samples of turf measuring one foot by one inch were drawn from each plot at equal intervals along the diagonals. The samples were analysed botanically in the laboratory, the components of the herbage being separated out and grouped into species. The roots were then discarded, the samples washed and boxed until air-dry. They were finally weighed and the percentage representation of each member by weight was calculated.

It should be noted that on account of the poor representation of Meadow Grasses in the herbage, both Rough and Smooth Stalked have been grouped together in the tables.

The results will be considered in the following order (*a*) the effect of phosphates, (*b*) the effects of phosphates and potash, (*c*) the effects of phosphates and lime and of lime alone.

Table I gives the results of analyses of the control and the phosphate plots.

It should be noted that control results are given for 1924 only, and as the results of the treated plots in 1925 and 1927 are directly compared with these, no allowance is made for seasonal variations in the herbage composition during the latter years. Consequently it is advisable to ignore small variations which cannot be considered significant in view of possible seasonal effects.

The Control herbage.

At the commencement of the trial the sward consisted of a thick mat of inferior herbage with a layer of about two inches of dead stems and leaves lying on the soil surface, and the field as a whole was badly grazed by stock. The plots were harrowed with a parmitter grass-harrow before the manures were applied, but owing to the thickness of the " mat " the operation was not very successful. This foggage consisted largely of Bent Grass which constituted nearly 50 per cent. of the herbage. Field Woodrush (*Luzula campestris*); Yorkshire Fog and Sweet Vernal also formed a considerable proportion of the herbage. The better grass species were very poorly represented, Fine Leaves Fescues, Meadow Grasses, and Crested Dogstail being the only members present and forming altogether only about 4 per cent. of the total. Moss and Buttercup (*Ranunculus repens*) were the most conspicuous members of the miscellaneous flora. Self-heal (*Prunella vulgaris*) was found to the extent of approximately 1 per cent. and the rest of the weed flora consisted of small fractions of Heath Bedstraw (*Galium Saxatile*), Yarrow, Dandelion, Mouse-ear Chickweed (*Cerastium vulgatum*), Cat's-ear (*Hypochaeris radicata*), Daisy, Tormentil (*Potentilla tormentilla*), and Sorrel (*Rumex acetosa*). It was obvious that the quality of the herbage left much room for improvement, and since this type of poor grassland is by no means uncommon in the county, the results of the trial should give a lead to the future treatment of such land.

TABLE I.

Percentage composition by weight.

	Control.	*Superphosphate.*		*Basic slag.*		*Gafsa phos.*		*Nauru phos.*	
	1924	*1924*	*1925*	*1924*	*1925*	*1924*	*1925*	*1924*	*1925*
Fine leaved fescues	2.9	6.6	6.8	3.4	5.1	3.5	5.8	4.1	3.5
Meadow grasses ...	1.1	1.4	5.2	2.7	4.0	2.5	4.1	2.9	1.9
Crested dogstail ...	.3	1.6	3.1	.7	.1	—	1.7	.8	1.3
Perennial ryegrass	—	—	.6	—	3.0	.1	.2	—	—
Wild white clover	5.8	6.9	4.5	7.8	5.0	9.8	4.7	5.9	4.9
Bent grass ...	46.1	45.3	45.6	47.3	42.7	42.7	42.5	45.2	45.1
Sweet vernal ...	6.5	8.1	6.3	5.9	9.0	12.5	6.2	9.2	10.3
Yorkshire fog ...	7.3	13.6	11.8	8.4	11.4	7.0	10.3	4.0	11.3
Mosses ...	3.8	1.6	3.7	4.6	5.0	4.3	4.0	6.7	6.1
Field woodrush ...	19.5	10.3	4.3	12.0	11.1	11.6	15.2	15.0	9.0
Buttercup ...	1.9	—	1.5	3.0	.4	—	1.5	1.5	3.4
Miscellaneous ...	4.8	4.6	6.6	4.2	3.2	6.0	3.8	4.7	3.2

(*a*) *Results of the phosphate applications.*

The phosphate applications alone have not produced any outstanding results, although a few more or less significant changes in herbage composition are evident on all the plots. As a rule the application of phosphatic manures to poor grassland encourages the development of Wild White Clover, and the extent to which this valuable pasture ingredient has been encouraged is often taken as a measure of the improvement produced. In this trial

however, the heavy phosphate dressings had very little effect on Wild White. There is evidence to show that the Meadow Grasses and Fine Leaved Fescues have been encouraged to some extent on all the treated plots, and that the latter species responded well to Superphosphate. Owing to the uneven distribution of Crested Dogstail and Perennial Ryegrass the variable occurrence of these species is not significant. Bent grass has remained practically unchanged, but Sweet Vernal and Yorkshire Fog show considerable variations in the two years on all the plots. The most significant feature is the rather pronounced increase of Fog on the Superphosphate plot. On the whole phosphate dressings have had little effect on Moss, but they have reduced Field Woodrush, the greatest reduction of the species being noted in the second year analysis of the Superphosphate plot.

Owing to the fact that none of the dressings have induced any very appreciable changes in the herbage composition, no data are available regarding the rate of action of the phosphates, and no striking differences are noted in their effectiveness. The plots were however very much better grazed in 1923 and the following years, and the herbage was obviously more palatable to stock. From observations made in the field the plots can be said to have been at their best in 1925, and since then they have gradually deteriorated although even in 1929 the boundary adjacent to the control was well defined. Considering the results in all their bearings it is obvious that phosphatic manures alone are incapable of producing the desired improvements in a herbage of this type, and it is obvious that the limiting soil factor is not phosphoric acid.

(*b*) *Results of phosphate with potash dressing*—Table II.

The table of analyses shows that Kainit in conjunction with a phosphate had in the first year, viz., 1924, resulted in a fair increase in the Wild White Clover population on all the plots. This improvement was, however, not maintained in the following year; in fact on the Superphosphate and Slag-Potash plots this valuable pasture ingredient had by then been reduced to a figure well below that of the Control in 1924. Such a result indicates that a manure like Kainit is not very lasting in its effects on Wild White. From the writer's experience of manuring trials at other centres where potash applications have proved beneficial, the effect on clover lasts for only two seasons. It should be noted that the manures in this trial were sown in March, 1923, and that, although no analyses were made in that year, there was ample evidence during the grazing season to show that the clover population had increased considerably. In this and other trials it has

TABLE II.

Percentage composition by weight.

	Control.	*Superphosphate and Kainit.*		*Basic slag and Kainit.*		*Gafso phos. and Kainit.*		*Nauru phos. and Kainit.*	
	1924	*1924*	*1925*	*1924*	*1925*	*1924*	*1925*	*1924*	*1925*
Fine leaved fescues	2.9	2.4	3.7	2.4	4.5	4.0	3.5	4.1	2.6
Meadow grasses ...	1.1	3.1	.8	2.7	2.9	1.3	2.9	1.7	.9
Crested dogstail ...	.3	.9	.7	.5	1.0	—	1.6	1.1	1.2
Perennial ryegrass	—	.5	.5	—	—	.3	.4	.5	—
Wild white clover	5.8	11.0	3.8	14.1	2.8	12.8	4.5	16.2	5.7
Bent grass ...	46.1	43.2	50.5	47.7	48.5	46.9	55.9	45.6	50.8
Sweet vernal ...	6.5	7.6	4.9	5.4	8.0	3.6	5.8	6.4	6.8
Yorkshire fog ...	7.3	12.4	12.7	5.6	8.8	7.1	10.3	8.2	11.6
Mosses ...	3.8	1.1	1.4	3.2	5.6	2.9	2.6	3.0	5.1
Field woodrush ...	19.5	9.9	16.9	2.6	2.6	18.0	6.2	7.9	11.7
Buttercup ...	1.9	3.3	1.5	12.8	12.2	—	3.2	.7	.3
Miscellaneous ...	4.8	4.6	2.6	3.5	3.1	3.1	3.1	4.6	3.3

been noticed that potash manures are capable of improving very considerably the texture and palatability of a herbage, and that in this respect, judging only by the grazing, their effectiveness often extends over four seasons.

From Table II it is evident that the Fescues and Meadow Grasses did not respond to the potash phosphate treatment. Bent and Sweet Vernal were little affected by the manures, and the same is true of Yorkshire Fog except on the Superphosphate-

Potash plot, where there has been a definite increase of the species in both years. On this latter plot Moss was considerably suppressed in both years. Field Woodrush shows considerable variations on the plots in the two years, although on the whole the manures have tended to reduce the species.

Considering the results as a whole the early promise of substantial improvement has not been fulfilled, the results are disappointing, and it is obvious that potash is not the limiting factor in the field. At the same time it can be confidently stated that there is a scarcity of potash in the soil, and that potassic fertilisers have an important part to play in the improvement of a pasture on a soil of this type.

(c) *Results of phosphates with lime, and of lime only*—Table III.

All the plots dressed with Ground Limestone showed very marked improvement from 1924 onwards, and it was decided to have these plots analysed again in 1927 in order to measure the extent of the improvement in the fourth year.

Fine Leaved Fescues, of which Red Fescue (F. *rubra*) was the predominating type, have increased considerably on all the limed plots. The species responded more readily to Slag and Super-Lime than to the Mineral Phosphate-Lime applications. They appear to have reached something like stability on the Super.-Lime plots by 1925, but on the other plots they have increased to a much higher figure by 1927.

The behaviour of the Meadow Grasses was very similar to that of the Fescues. Superphosphate with Lime has not produced such striking effects on the species as have the other three dressings; by 1927 the species were thickly distributed on the latter plots, and formed approximately one fifth of their total herbage as compared with a 1 per cent. occurrence on the 1924 Control plot. Ground Limestone alone has been effective in encouraging the development of both Meadow Grasses and Fescues, but better results have followed from phosphate and lime applications.

Crested Dogstail, although unevenly distributed in the herbage, has in some cases, notably on the Super-Lime plot, responded to treatment and forms a fair percentage of the total herbage on this plot throughout the trial period.

Wild White Clover plants were prominent on the plots in 1924, but in the following years they declined rapidly on practically all the plots, and were replaced by a vigorous and luxuriant growth of excellent grasses.

One of the most outstanding effects produced by Ground Limestone in this trial was the drastic suppression of Bent Grass,

TABLE III.

Percentage composition by weight.

	Control.	*Superphosphate and lime.*			*Basic slag and lime.*			*Gafsa phos. and lime.*			*Nauru phos. and lime.*			*Lime.*		
	1924	*1924*	*1925*	*1927*	*1924*	*1925*	*1927*	*1924*	*1925*	*1927*	*1924*	*1925*	*1927*	*1924*	*1925*	*1927*
Fine leaved fescues	2.9	11.4	15.2	14.4	9.0	12.8	21.5	2.8	13.2	20.9	5.0	5.8	16.5	2.9	5.8	10.0
Meadow grasses ...	1.1	4.7	5.6	7.9	4.8	13.4	16.7	3.2	14.5	21.0	2.0	6.2	19.3	2.9	6.2	9.4
Crested dogstail ...	.3	6.2	4.6	5.2	.5	1.4	3.5	.6	.9	.2	—	2.7	3.4	2.0	2.7	2.0
Perennial ryegrass	—	.3	.6	1.4	—	1.2	.2	—	.6	.2	—	—	.1	.5	—	.8
Wild white clover	5.8	12.0	2.5	10.9	8.8	3.6	3.1	9.0	3.8	4.3	9.2	3.5	3.6	7.6	3.5	8.0
Bent grass ...	46.1	35.7	35.8	16.3	42.2	39.9	16.7	46.8	40.2	19.3	38.4	40.7	20.4	51.5	40.7	28.5
Sweet vernal ...	6.5	6.3	5.4	13.8	2.6	3.9	5.3	4.4	1.6	4.3	7.8	9.9	6.1	7.4	9.9	5.9
Yorkshire fog ...	7.3	7.6	13.1	8.3	6.0	11.5	11.5	6.1	9.9	9.9	7.9	6.4	7.5	7.5	6.4	10.2
Mosses ...	3.8	1.1	3.3	12.5	6.0	2.8	11.4	2.3	3.7	9.6	8.3	5.9	11.8	4.7	5.9	7.2
Field woodrush ...	19.5	2.6	4.9	2.3	14.4	5.2	1.9	21.9	6.2	2.7	14.1	12.4	3.3	6.3	12.4	7.7
Buttercup ...	1.9	4.6	5.2	2.3	2.0	.7	4.0	.1	2.6	2.8	2.8	2.6	3.7	2.1	2.6	4.5
Miscellaneous ...	4.8	7.5	3.8	4.7	3.7	3.6	4.2	2.8	2.8	4.8	4.5	3.9	4.3	4.6	3.9	5.8

which, on the Super-Lime and Slag-Lime plots, was reduced by 1927 to practically a third of the total on the Control plot. Similar results, although not quite so pronounced, were obtained from the other lime-phosphate dressings. No striking reduction of the species occurred in the first two years, not in fact until the "mat" of undecayed organic matter consisting mostly of dead stems and leaves of Bent had been burnt away, and the sward converted into a thin carpet of grasses and clover.

The behaviour of Yorkshire Fog and Sweet Vernal has been variable, the occurrence of each on any particular plot showing rather pronounced fluctuations from year to year. Treatment with Slag-Lime and Gafsa-Lime has apparently adversely affected Sweet Vernal, while Yorkshire Fog was stimulated by these and by the Super-Lime dressings. This latter dressing has been definitely harmful to the Moss flora, especially in the first year or two, and on reference to Tables I and II the same result is observable on the plots dressed with Superphosphate. This was probably due to the burning effects which followed the heavy application of this fertiliser.

Field Woodrush rapidly died out of the herbage from 1924 onwards, and in this connection phosphates with lime proved much more effective than lime alone.

In 1923 and 1924 casual observations of the herbage showed no difference in the appearance of the limed and unlimed plots. A very striking difference was, however, apparent in the early spring of 1925. At this time sheep and lambs roaming over the deer park and adjacent land showed a very pronounced partiality to the herbage on the limed plots. The Fine Leaved Fescues, which were very prominent on these plots, were very thoroughly clipped down by the sheep, and the well clipped herbage marked out the boundaries of the plots quite definitely. From 1925 onwards the limed plots were outstanding in general appearance, and were always closely grazed. With the disappearance of the "mat" the herbage assumed a fine close texture, and even at the present day the limed areas can be picked out from a distance.

To summarise, it may be stated that the general appearance of the limed plots and their excellent grazing qualities, coupled with the results of the botanical analyses demonstrate conclusively the far-reaching benefits which Lime is capable of giving when applied to this type of pasture. The importance of phosphates in conjunction with lime is also well brought out in the results.

Summary and conclusions.

(1) Considering the results from all the treated plots, the

excellent effects produced by Ground Limestone with Phosphates are outstanding.

(2) These are the only plots on which the improvement has attained anything like a permanent character. In fact the herbage continued to improve up to the fourth year following manurial application.

(3) The heavy dressings of Phosphates given with and without Potash have proved disappointing, both in regard to extent and duration of effect on the herbage. It is obvious that no satisfactory results can be expected from these plant food ingredients on a pasture type of this nature until the soil acidity has been corrected.

(4) A marked stimulation of excellent grass species has occurred on the plots treated with phosphates and lime. The effect of lime alone though considerable was not so marked on these species.

(5) A pronounced reduction of Bent Grass and Field Woodrush is observed on all plots treated with Ground Limestone. The presence of these two species coupled with dense fibrous matted growth may be taken as reliable indications of a pasture badly in need of a good dressing of lime.

(6) There is no evidence of a permanent improvement in the Wild White population of the herbage, even on the well grazed herbage of the limed plots.

(7) Superphosphate has adversely affected the Moss flora in the first two years, and is to be recommended for dressing mossy pastures. The rapid increase of Moss apparent on all the limed plots by 1927 is not a matter of great concern. The 1927 sampling was done in early spring before growth was well advanced, and the moss figures in the tables for that year give what may be termed the winter phase occurrence of the species. When the pasture growth was well forward the Moss disappeared to a very large extent. Even the best of pastures present a somewhat mossy appearance in the winter and early spring.

(8) Superphosphate Lime and Slag Lime were quicker in their action on the excellent grass species than were the Mineral Phosphate Lime dressings.

(9) Taking all the results into consideration little differences are observable in the relative effectiveness of the Phosphates tested. The Mineral Phosphates appear to be slower in their action than the other phosphates, but so far as these results go they are ultimately quite as effective as the latter.

(10) The appeal to the animal, in this case involving a comparison of the plots with regard to the manner in which they have

been grazed in the trial period, clearly demonstrates the superiority of Ground Limestone as a basal manurial ingredient for this type of herbage.

One must also not lose sight of the fact that where a herbage is constantly closely grazed, the relatively inferior constituents are enhanced in feeding value, and bearing this in mind one is justified in saying that the improvement produced on all the treated plots is really more pronounced than is indicated in the tables of analyses.

General.

There are considerable areas of rough grazing lands in Caernarvonshire which are covered with a fibrous mat of undecomposed vegetable matter, and the herbage of which is characterised by a predominance of Agrostis (Bent grass). In many of these cases, particularly in the Lleyn district, the soil is of a light sandy nature, and is particularly deficient in Lime. On such land Lime will undoubtedly form an important ameliorative agent, breaking up the mat, decreasing Agrostis, and encouraging the finer and excellent grasses. On such land the basal manurial dressing should be Lime, and this should be followed by applications of Phosphates and Potash. It may be confidently stated that by a system of manuring as outlined above, coupled with judicious management, this type of poor grazing land could be permanently improved almost beyond recognition.

Acknowledgements.

The writer gratefully acknowledges his indebtedness to Dr. R. Alun Roberts for valuable suggestions in connection with this experiment, and to Professor G. W. Robinson for the soil analyses.

THE RECOVERY OF NITROGEN IN PASTURES FROM THE APPLICATION OF NITROGENOUS MANURES.

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At the present time, it is the economic aspect of nitrogenous manures upon which attention is mainly focussed, that is, whether the return is adequate for the expenditure incurred in their application. There are, however, other important considerations having a direct bearing on the mechanism of the reactions involved, that may materially affect the whole economic problem. The chief of these is concerned with the amount of nitrogen it is possible to recover in the produce of pastures from the nitrogenous manures applied. If this return is low, it may be concluded that there is a loss either by drainage or by actual escape of nitrogen as gas. If the return is considerable, the efficiency of the sward in utilising the manure may be brought forward as an explanation. If, on the other hand, the increase in nitrogen returned from the plant is greater than that supplied in the manure, it is obviously of importance to ascertain from what source or sources the increment was derived.

It is fully realised that prolonged investigation along several lines is essential for the complete elucidation of this aspect of the question. At the same time, it was considered that the experiments carried out by the Welsh Plant Breeding Station on the effect of heavy dressings of nitrogenous manures on the productivity and chemical composition of the produce of swards had reached such a stage that a review of the position in the light of the data in hand might be of advantage at the present juncture.

These experiments are in progress in a large number of different centres, while investigations have also been carried out at the Station itself in Brickfield and Penglais field. In both these fields the soil is typical of the majority of the sedentary soils in the neighbourhood of Aberystwyth. The trials carried out at Brickfield have been dealt with in detail in a previous publication (1), while other questions in connection with the Penglais experiments will be considered elsewhere. It is proposed to confine this paper to one aspect of the experiments conducted in these two fields, viz., the increment of nitrogen yielded by the plant in its relation to the nitrogen supplied in the manure.

The Penglais experiments.

In these experiments a large number of small plots each having an area of 24.2 square yards were sown with indigenous and commercial strains of the chief grasses. The periodical growth was ascertained by taking fifteen cuts from each plot, one cut representing 1 sq. foot. The dry matter of these cuts was weighed and subjected to chemical analysis. Immediately after the sampling the plots were grazed bare by allowing one sheep into each plot. This generally occupied about two days. The growth for the next month or any desired period was then ascertained by repeating the sampling at the end of that period.

All the plots received a basal dressing of potash and phosphate on March 24, 1927, at the rate of 80 lbs. potash (K_2O) and 78 lbs. phosphate (P_2O_5). While the control plots received no nitrogenous manures other than the sheep droppings during the grazing after

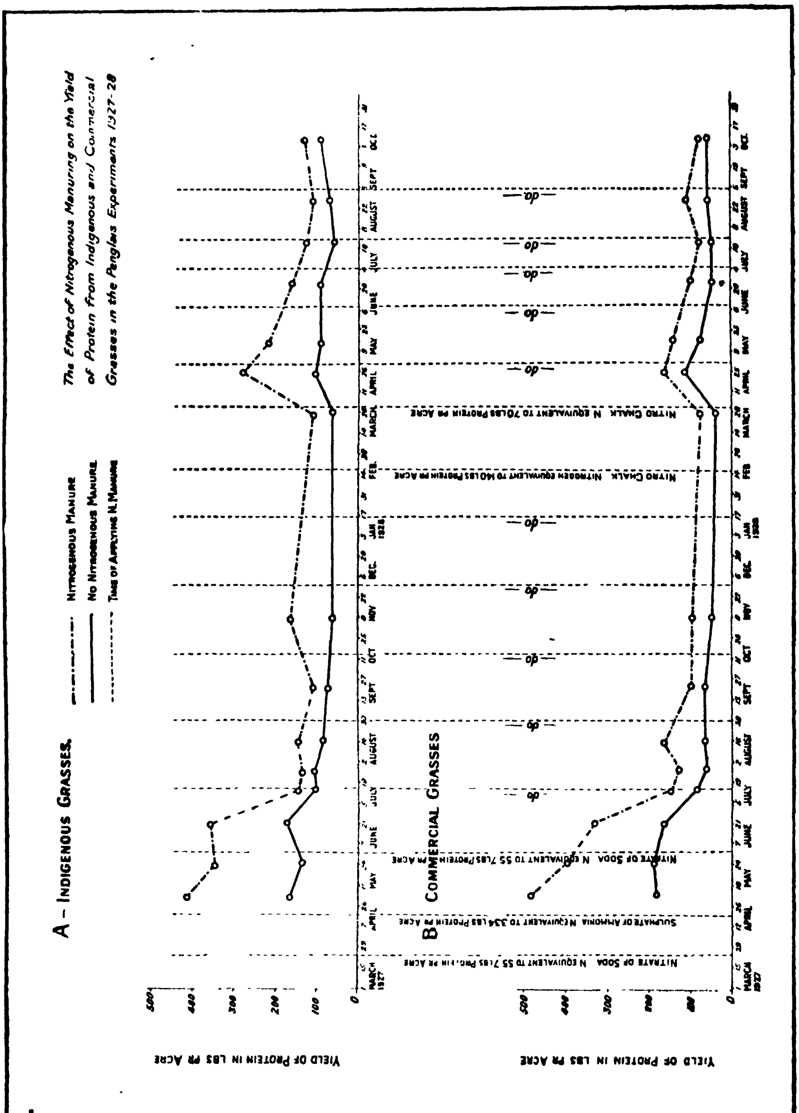

FIG.1.

each sampling, the others received in addition equal doses of soluble nitrogenous manures on the same dates at frequent intervals. The control plots and the heavily manured plots were otherwise treated in an identical manner.

The results obtained during 1927 and 1928 are set out in the graphs in Fig. 1. A shows the yield of protein in lbs. per acre obtained from the cuttings taken at different dates in the case of (1) indigenous grasses that received artificial nitrogenous manures and (2) the same indigenous grasses to which no artificial nitrogenous manure was applied. Similarly B gives the yield of protein calculated in lbs. per acre from (1) commercial grasses receiving artificial nitrogenous manures and (2) the same commercial grasses to which no artificial nitrogenous manure was applied.

A survey of the results as set out graphically shows clearly that the manuring with artificial nitrogen has had a marked effect on the yield of protein in the case of both the indigenous and commercial grasses, the yield of protein being generally doubled.

While there is a striking similarity between the behaviour of the indigenous and commercial strains in the control plots up to September, 1927, the indigenous strains subsequent to this date are decidedly more persistent in giving a higher protein yield than the commercial strains. There is the same striking similarity between the behaviour of the two strains in the nitrogen manured plots up to September, 1927, but after this date the indigenous grasses generally show a more marked response to the manure.

If the indigenous grasses are considered up to the end of June, 1927, it will be seen from Fig. 1 that cuts had already been made at three different dates. It will also be noted that three different applications of manure had been given before the third cut on June 22 was taken. The details of the three manurial dressings are given below, the lbs. protein equivalent being obtained by multiplying the lbs. nitrogen per acre by 6¼.

Date of application.	*Manure.*	*Percent. nitrogen.*	*Lbs. manure per acre.*	*Lbs. nitrogen per acre.*	*Lbs. protein equivalent per acre.*
March 24	Nitrate of soda	15.5	57.5	8.91	55.7
April 21	Sulphate of ammonia	21.06	254.0	53.5	334.0
June 1	Nitrate of soda	15.5	57.5	8.91	55.7
Protein equivalent supplied to N. plots up to June 22 ...					445.4

The details of the protein yields in the case of the indigenous grasses were as follows, the protein being obtained as already indicated.

lbs. protein per acre.

Date of cutting.	*Control Plots.*	*Nitrogen Plots.*	*Increment in Nitrogen Plots.*
May 3	168	414	246
May 25	140	349	209
June 22	172	358	186
Total increment in N. plots up to June 22 ...			641

From the above it is clear that while the nitrogen supplied in the artificial manures was equivalent to 445 lbs. protein, that gained from the plant amounted to 641 lbs.

The commercial grasses received identical manurial dressings to the indigenous strains, and the protein yields in their case was as follows :—

lbs. protein per acre.

Date of cutting.	*Control Plots.*	*Nitrogen Plots.*	*Increment in Nitrogen Plots.*
May 3	199	483	284
May 25	185	397	212
June 22	161	329	168
Total increment in Nitrogen plots up to June 22 ...			664

Here the yield of protein amounted to 664 lbs. against 445 lbs. protein which would be the maximum amount that could be derived from the nitrogen of the manure on the unlikely assumption that all this nitrogen was recoverable by the plant.

This increment of nitrogen is so high in both the indigenous and commercial grasses that it is of special interest to note how much increase was derived from each individual grass. This is shown from the protein yield per acre given in Table 1.

Table I shows that although there is a considerable variation in the increment of protein obtained from the different grasses, this increment is invariably greater than the amount of protein which it would be possible to derive from the artificial manure. A close agreement exists in the increment from the two strains of Italian rye grass, and the four strains of perennial rye grass, but it is subject to greater variation in the other grasses. The lowest increment was obtained from indigenous cocksfoot and commercial timothy.

TABLE I.

The effect of soluble nitrogenous manures on individual grasses as shown by three pasture cuts on May 3, 25, and June 22, 1927.

Grass.	*Indigenous.* *Lbs. protein per acre.* *Control Plot.*	*Nitrogen Plot.*	*Increment.*
Italian rye grass	427	1,055	628
Cocksfoot	622	1,080	458
Meadow foxtail	669	1,400	731
Perennial rye grass	284	916	632
Perennial rye grass	433	1,073	640
Timothy	438	1,197	759
Mean increment per acre ...			641

Grass.	*Commercial.* *Lbs. protein per acre.* *Control Plot.*	*Nitrogen Plot.*	*Increment.*
Italian rye grass	497	1,144	647
Cocksfoot	833	1,623	790
Meadow foxtail	545	1,352	807
Perennial rye grass	392	977	585
Perennial rye grass	611	1,258	647
Timothy	394	904	510
Mean increment per acre ...			664

The Penglais pasture experiments during 1927-28 can be summarised as follows :—

1. Manures applied from March 24, 1927—October 9, 1928.

	Lbs. per acre.	*Percent. N.*	*Lbs. N. per acre.*	*Lbs. protein equivalent per acre.*
Sulphate of ammonia	254	21.06	53.5	334
Nitrate of soda ...	403	15.5	62.5	390
Nitro chalk ...	896	10	89.6	560
Total protein equivalent of manures applied ...				1,284

From the above it is seen that the total amount of artificial nitrogenous manures applied during the period under consideration amounted to 1,284 lbs. protein equivalent per acre. The increased protein yield from all the pasture plots receiving these manures amounted to 1,224 lbs. per acre. This represents a yield of 95 per cent. Of the total quantity of soluble nitrogen used, 250 lbs. protein equivalent were applied in the winter when no appreciable growth occurred for its immediate utilisation, and when the losses through drainage must have been heavy. One is therefore justified in concluding that in the Penglais experiments more extra nitrogen was recovered in the pasture than would be possible if the artificial manures were the only source of this nitrogen. The question therefore naturally arises from what other source or sources could some of this extra nitrogen have been derived. One source would be the sheep. As more protein was consumed by the sheep on the plots receiving artificial nitrogen than on the control plots, it can be concluded that the former plots were more heavily manured by the sheep. The heavier sheep manure would be an additional contribution, over and above the artificial manures, towards the enhanced growth in the nitrogen plots. Without quantitative data as to the nitrogen balance of the animals, it is however impossible to arrive at the significance of this factor. Nutrition experiments conducted at Cambridge (2) show that there can be wide fluctuations in the nitrogen voided per day in the urine of different sheep under the same conditions of feeding. Thus over a period of fourteen days it was found that while one sheep voided 26.14 grms. nitrogen in the urine per day, another voided 36.58 grms., although the sheep were fed on identical amounts of the same pasture. It is obvious that the discrepancy could be much greater over a period of two days. If a discrepancy of this magnitude had occurred in the Penglais experiments it would amount to 560 lbs. of protein per acre over the period under consideration (March, 1927—October, 1928). In other words, it would be equal to 46 per cent. of the increment of protein in the

2. Protein yields for above period.

	Number of 1/200 acre plots.		*Protein yield from plots.*				
	Control.	*Nitrogen.*	*Control.*	*Nitrogen.*	*Total increment.*	*Per plot.*	*Per acre.*
1927	36	36	169.5	338.3	168.8	4.69	938
1928	24	24	78.3	112.5	34.2	1.43	286
Total protein equivalent from nitrogen plots ...							1,224

nitrogen plots. It should be pointed out that while the short period over which the sheep had access to the plots would tend towards a high discrepancy in the amount of nitrogen voided, the large number of sheep included in the experiment would tend to lessen the interference from this source. The possibility that the sheep would have an appreciable influence on the nitrogen balance of the pasture plots can, however, not be overlooked. It should be borne in mind that the food in the plots manured with artificial nitrogen was entirely different in composition from that in the control plots. There is, therefore, the further possibility that the richer pasture might have had a greater effect on the nitrogen voided in two days than on the nitrogen consumed by the animal in that period.

It is therefore clear that in an experiment of this kind a correct assessment of the effect of artificial nitrogenous manuring on the protein of pastures can not be arrived at without a quantitative knowledge of the part played by the animal. Without such a knowledge it is impossible to ascertain how much of the improved yield should be allocated to the manure, how much to the interference of the animal itself, and how much to the other possible sources that are referred to when dealing with the Brickfield experiments.

The Brickfield experiments.

While the soil on which the Brickfield experiments were conducted was very similar in mechanical composition to that of the Penglais trials, the conditions governing plant growth were entirely different. The Penglais plots were laid out on a slope above which the higher reaches of land provided a reserve supply of water. This higher land also afforded shelter from the east wind. The portion of the field in which the Brickfield experiments were conducted was situated at the crest of a hillock, so that it would more readily suffer from drought and was fully exposed to the east. Further, while the soil in Penglais received a dressing of superphosphate and kainit immediately before the commencement of the experiment in March, 1927, no manure has been applied to the Brickfield soil since January, 1924, when it received 6 cwt. per acre of basic slag. It is, therefore, obvious that the conditions were decidedly more favourable at Penglais than in Brickfield, and this is reflected in the fact that while 800 lbs. protein per acre were derived from Italian rye grass in the control pasture plots in Penglais during 1927, a yield of only 415 lbs. of protein was obtained from a mixture of Italian rye grass and red clover during the same season at Brickfield under a somewhat less frequent system of cutting.

While the Penglais experiments in 1927 were concerned with the effect of nitrogenous manures on different grasses under the same management, those at Brickfield had the object of finding the effect of these manures on one simple mixture, under different systems of management. Three nitrogenous manures were in use at the Penglais experiment, viz., nitrate of soda, nitro-chalk, and sulphate of ammonia; while nitrate of soda was the only

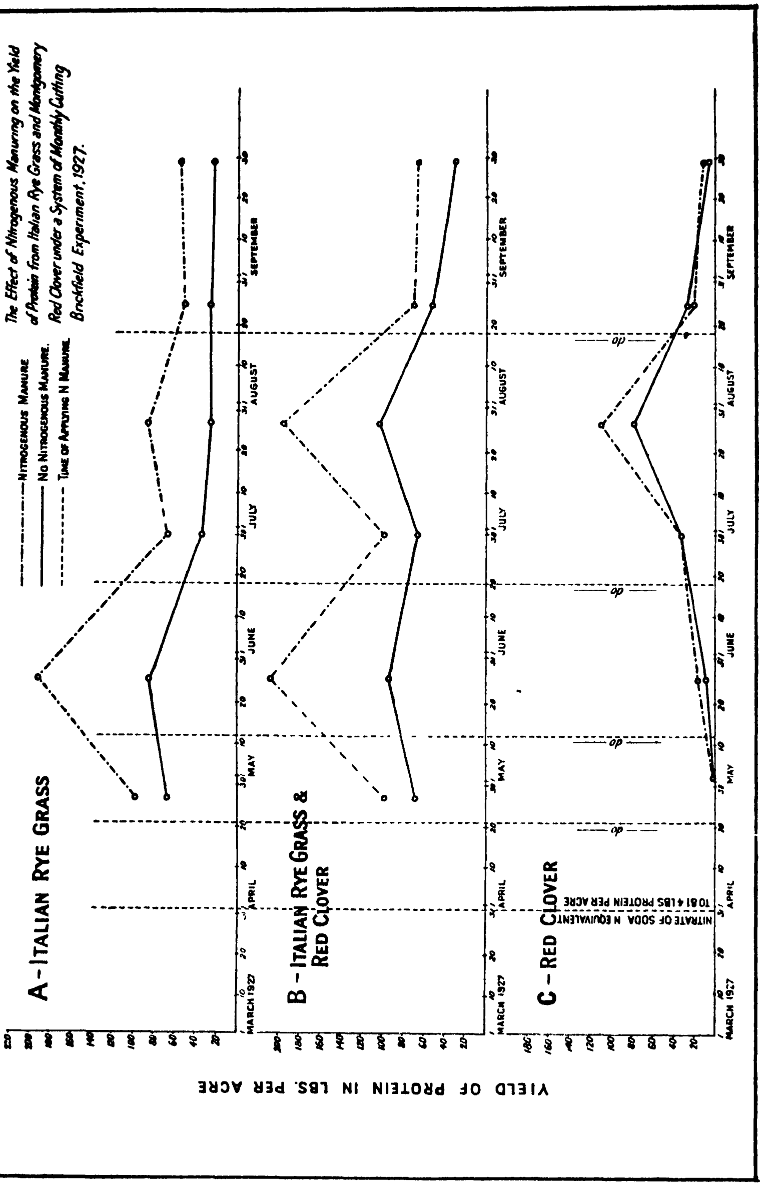

FIG. 2. *The Effect of Nitrogenous Manuring on the Yield of Protein from Italian Rye Grass and Montgomery Red Clover under a System of Monthly Cutting Brickfield Experiment, 1927.*

artificial manure applied at Brickfield. The area in which the Brickfield experiments were carried out was grazed by sheep for the last few days of March before the experiment was commenced; but as no sheep entered the plots after March 30, 1927, the possible interference from this course would be less serious than in the Penglais experiments.

The 1/100 acre plots in the Brickfield pasture experiments were subjected to two radically different methods of management. One method was to subject the plots to a monthly system of cutting, the produce being cut, weighed and analysed at the end of each month. The other method was to cut, weigh and analyse the produce at the end of each week.

Protein recovery from the monthly cuts at Brickfield.

The effect of nitrate of soda on the protein yield of the monthly cuts is shown in Fig. 2. From this it will be seen that the effect on the yield of protein both from the Italian rye grass and from the mixture of Italian rye grass and clover is similar to that in the Penglais experiments, that is to say the yield has been approximately doubled as a result of the application of soluble nitrogen. The greatest yield of protein as a result of applying the manure is obtained towards the end of June, there being but a small response at the end of April. This is in marked contrast to the phenomenal response obtained at that time in the Penglais experiments.

Although the effect on the yield of the protein in the grass at Brickfield is similar to that in the Penglais experiment, there is not the same recovery of nitrogen. The recovery of nitrogen in the six pasture cuts from Italian rye grass alone amounted to 70 per cent. of the nitrogen applied in the manure. It will be found from Fig. 2 C. that the effect of the manure on the yield of protein from the red clover is very small compared with its effect on the protein yield of the grass. The recovery of nitrogen effected by the mixture of Italian rye grass and red clover amounted to 77 per cent. As the clover was relatively indifferent to the action of the manure, it follows that the recovery would have been higher had the plots been entirely devoted to Italian rye grass instead of a mixture of grass and clover. While it is impossible to give an exact figure for the nitrogen recovery had the whole plot been occupied by Italian rye grass, a conservative estimate shows that it would at least be higher than 80 per cent. When the slow rate of growth is taken into consideration, and also the rainfall during the period of the experiment (April-September) amounting to 56 inches per annum, it will be realised that such a high recovery was remarkable from nitrate of soda.

The important contribution made by red clover towards the protein yield of pastures even under adverse circumstances is brought out by the monthly cutting system at Brickfield. Reference has already been made to the fact that under such a system the grass grew away from the clover, and to a certain extent shaded it, and that this suppression of clover had a serious influence on the composition of the produce (3). As enthusiastic statements are often heard to the effect that the contribution of clovers towards the fixation of atmospheric nitrogen is negligible compared with the medium of soluble nitrogenous manures, it is interesting to compare the effect of frequent dressings of nitrate of soda with that of the suppressed red clover, and this comparison is made in Table II.

TABLE II.

Date of cutting.		*Protein yield from I.R.G. in control plot.*	*Protein yield from I.R.G. in manured plot.*	*Increase of protein due to application of nitrate.*	*Protein yield from I.R.G. and red clover in control plot.*	*Increase of protein due to red clover.*
April	27	68.1	98.3	30.2	68.1	nil
May	26	85.0	192.2	107.2	93.6	8.6
June	30	34.4	67.3	32.9	66.9	32.5
July	28	25.8	85.8	60.0	104.3	78.5
August	25	26.7	51.2	24.5	52.1	25.4
Sept.	29	23.5	55.3	31.8	30.1	6.6
Total	...	263.5	550.1	286.6	415.1	151.6

It is seen from Table II that the contribution of the red clover amounted to more than half that of the nitrate of soda; in spite of the fact that it had no appreciable influence till June and that the conditions for its subsequent development were unfavourable. There is no data at present available from which to compare the effect of red clover with that of the manured grass on the store of soil nitrogen. In this experiment at Brickfield only a fraction of the plot was occupied by red clover, and it is the effect of the suppressed clover plant grown on this fraction of the total area that is given in Table II. It would therefore be of great interest to know how the protein yielded by a given area of land devoted entirely to some of the red clover strains recently developed by the Welsh Plant Breeding Station would compare with that yielded by an equal area devoted to a grass heavily manured with soluble nitrogenous manures. In order to render such a comparison complete it would be necessary to determine :—

(*a*) How the reserve supplies of organic nitrogen in the soil had been affected by these two treatments, and

(*b*) The relative feeding value of the protein from the two areas both for flesh and milk production.

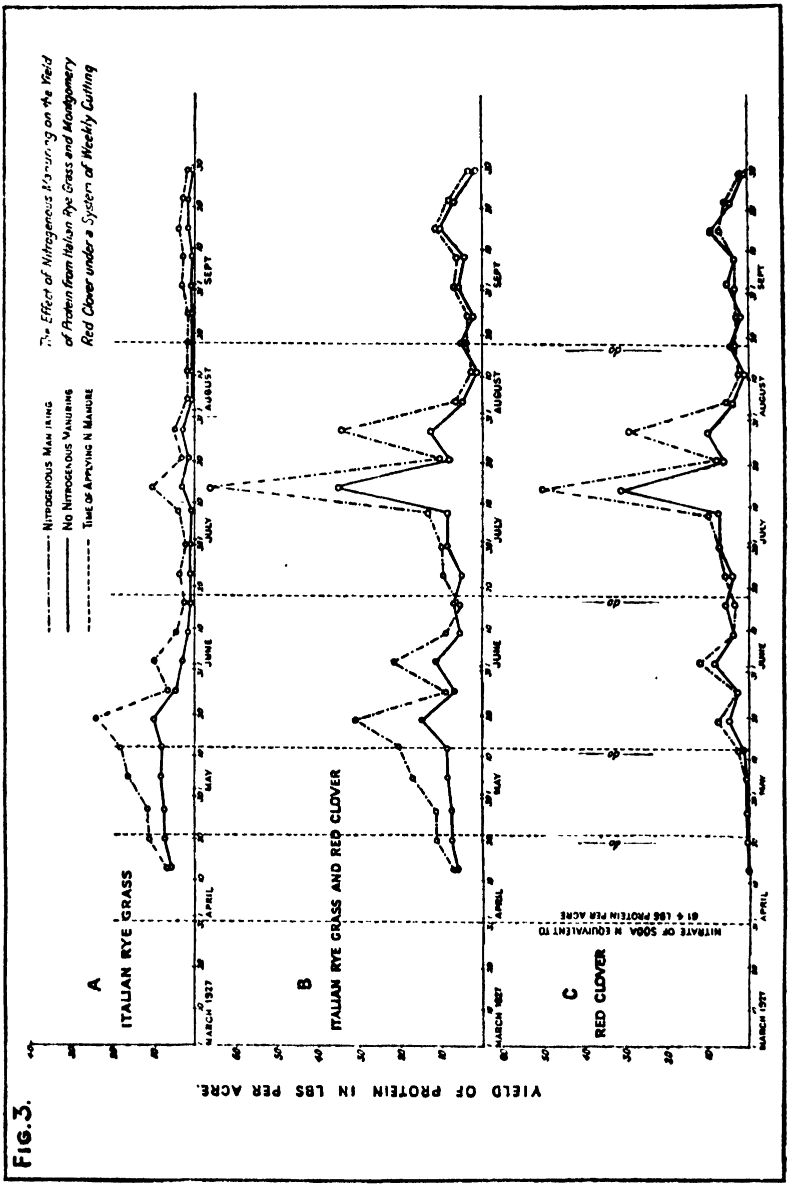

FIG. 3.

Weekly pasture cuts in Brickfield.

The effect of nitrate of soda on the protein yield of the weekly cuts is given in Fig. 3. It will be noticed that here again the general effect of the nitrogenous manure on the Italian rye grass is to double the protein yield of the plant. The effect of nitrogen is found to be much smaller on the clover except in the case of the cut taken on the 28th of July, when the protein yield was more than doubled. It will be noticed that the yield of clover has sometimes been actually depressed in the nitrogen plot during September. This small effect of nitrate of soda on the clover is reflected in the mixture (Fig. 3B), and is very apparent towards the end of the season, where the increment of nitrogen in the manured mixture compared with the control is much less than in the case of the Italian rye grass alone.

Evidently one of the most important factors in the recovery of nitrogen from a sward is the rate at which the swards can manufacture protein when no nitrogen is applied. The greater the amount of protein which the plant can produce on the control plot, the higher is the recovery of nitrogen which it can effect when soluble manure is applied to it. This is clearly brought out in Table III.

TABLE III.

Showing the effect of the rate of protein production on the recovery of nitrogen from nitrogenous manures as shown by Italian rye grass.

Experiment.	*Protein produced per acre during season.*			*Increment of protein for every 100 lbs. yielded by control plot.*	*Percent. recovery of nitrogen.*
	Control plot.	*Nitrogen plot.*	*Increase.*		
1927 Penglais experiment	800	1725	925	116	101
1927 Brickfield monthly cuts	264	550	286	109	70
1927 Brickfield weekly cuts	76.3	155.4	79.1	104	19

From the above it will be seen that the increment of protein for every 100 lbs. originally produced remains fairly constant, and is not greatly dependent on the rate of growth. At the same time it is evident that the recovery of nitrogen is intimately connected with this rate of growth. In the case of the Penglais experiments where a high rate of protein production was attained by the control plots, an exceptional recovery was effected. In the case of the Brickfield weekly cuts, on the other hand, the frequent cutting had injured the plants to such an extent that the rate of protein formation was exceedingly low. Here it will be seen that only one-fifth of the nitrogen applied as manure was recovered in the plant.

It is noteworthy that one gains more insight into the mechanism of the action of nitrate of soda on pasture from this system of severe treatment than from the more normal way of cutting at longer intervals. Just as starvation metabolism in the case of the animal, while being an uneconomical procedure, has thrown important light on questions of nutrition; so a drastic treatment of the plant although destroying its productivity may afford fresh information as to the way it reacts to its environment. Nitrate of soda has always been regarded as a quick-acting manure, but these weekly cuts indicate that the manure also encourages secondary reactions which take some time in showing their maximum effect on the plant. This is realised if Fig. 3A is closely followed. The maximum effect of the first dressing applied on March 31 is obtained no earlier than April 20, three weeks after its application. The same is true of the second dressing, that at least three weeks had elapsed before the greatest effect was shown on the plant. A very high increment of protein was obtained on May 19, seven days after the third dressing applied on May 12, but this may be partly due to the influence of the second dressing culminating on this date. At any rate, while only a small increase in protein yield was obtained from the cut of May 26, a very pronounced increment was forthcoming on June 2, three weeks after the third dressing of manure. The fourth dressing applied on June 19, shows an immediate effect five days after its application. While this immediate effect subsides, there appears a secondary effect which makes itself apparent on July 9, and reaches a climax on July 14, twenty-six days after the application of the manure. A pronounced effect is obtained on September 1st, fourteen days after the application of the fifth dressing on August 18, but a somewhat greater influence on the plant is found to occur on September 8th, three weeks after the dressing with nitrate of soda.

These results indicate that nitrate of soda may act in more than one way. In addition to having an effect which, given an ample water supply, is more or less immediate, it produces a secondary action that requires a pericd of three weeks to have its maximum effect on the plant.

This time factor necessary for the secondary reaction to fully manifest itself points to the probability that it is of a bio-chemical nature. It may be that a portion of the nitrate is assimilated by soil organisms and subsequently liberated. That such a process is likely is shown by Bizzell's observation of a rapid disappearance of nitrate when sodium nitrate was added to Timothy sod.

The loss appeared to be due only in part to the absorption of nitrogen by the growing crop, and it could not be accounted for by leaching (4).

There is, however, the further possibility that the nitrate of soda may have either encouraged the fixation of atmospheric nitrogen or else stimulated the decomposition of soil nitrogen. Either of these effects would afford a satisfactory explanation of the phenomenally high nitrogen recovery to which reference has already been made. The first possibility is exceedingly unlikely in view of the fact that nitrates are readily utilised by non-symbiotic nitrogen fixing bacteria; and that consequently the presence of nitrates in the medium inhibit the fixation of atmospheric nitrogen (5). The presence of nitrates in the medium and in the soil also diminishes nitrogen fixation by symbiotic organisms. This has been demonstrated by Nobbe, Richter and others (6), and it was found to be due not to any injurious influences of the nitrate but to the fact that the plant, capable of obtaining its nitrogen from the soil, represses the development of the nodules. These observations explain the contrast that has been shown to exist in the Brickfield experiments between the effect of nitrate of soda on Italian rye grass and its effect on Red Clover.

The drainage investigations of Hendrick, on the other hand, have shown that excessive manuring with soluble nitrogenous manures stimulated the production of nitrates from the materials naturally present in the soil (7). The Craibstone soil on which these drainage investigations were conducted is similar in many respects to the sedentary soil at the Welsh Plant Breeding Station. It is therefore suggested that the high protein increment obtained in these pasture experiments may be attributed in part to the reserve organic nitrogen supplies already present in the soil. It is premature to suggest the relative significance of this factor in comparison with the interference of the animal. There is no doubt, however, that more light is necessary on these questions before the real economic value of nitrogenous manures towards increasing the productivity of pastures can be ascertained.

Summary and conclusions.

A study of the results obtained from experiments carried out at the Welsh Plant Breeding Station on the effect of soluble nitrogenous manures on pastures reveals that more extra nitrogen was recovered in the pasture than would be possible if the artificial manures were the only source of this nitrogen. The interference of sheep as a disturbing factor is discussed, and it is

emphasised that a true interpretation of the effect of soluble nitrogen on pastures is impossible without a quantitative knowledge of the part played by the animal.

The weekly cuts at Brickfield show that the recovery of nitrogen even in the case of a manure such as nitrate of soda and under conditions of high rainfall takes some time before it is completed. While part of the nitrogen is recovered immediately, a considerable portion is returned in the plant three weeks after its application. It is known that soluble nitrogenous manures encourage the growth of soil bacteria, the proteins of which are subsequently rendered available to the plant. There is, however, such a high increment of plant nitrogen as a result of nitrogenous manuring that a further possibility is suggested, viz., that the manure has the indirect effect of rendering a larger quantity of the soil nitrogen available as plant food than would have been rendered without its application.

A very high rate of protein synthesis is possible by heavily manuring a grass with soluble nitrogen. It is shown, however, that the rate of protein synthesis effected by means of clover to which no nitrogen has been applied is by no means insignificant in comparison with this, even when the clover is grown under adverse circumstances. A close comparative study of these two methods of protein synthesis would therefore be of both scientific and practical importance, especially in view of the large amount of work on clovers which has already been carried out by the Welsh Plant Breeding Station.

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THE EFFECT OF CUTTING SAINFOIN AT DIFFERENT STAGES ON THE YIELD AND CHEMICAL COMPOSITION OF HAY AND AFTERMATH.

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This paper deals with the yield and chemical composition of common and giant sainfoin cut as hay and aftermath, the hay being taken at different stages of maturity. The crop was grown without a cover crop at the Green Farm Experimental Plots, Cardiff, where the soil is a mixture of drift lying on an outcrop of Lower Lias. Although situated outside the present sainfoin growing area of Glamorgan, the soil is well suited for the purpose, containing as it does adequate amounts of lime, phosphate and potash.

In this country sainfoin is regarded as excellent food for sheep and lambs, and prevents scouring. " Down shepherds prefer sainfoin hay beyond all others ". On the Continent sainfoin is the ideal food for horses.

Malden[1] says that in the first cutting year the plants have not attained nearly full growth and hence it is not wise to let the crop get too old so that it is cut at rather an earlier stage than in subsequent years. If only intended for a short ley it may be allowed to go into full flower before cutting, but should not be allowed to go to seed as the plant loses in vigour thereby, and so with all years unless seed is wanted.

For the purpose of the experiment eight plots were laid down, each plot consisting of three drills 24 feet in length and three feet apart. Two plots were sown on April 23, one of the common variety, No. 7, 1927, and the other of giant, No. 8, 1927, at the rate of 576 seeds to each drill. The remaining plots in pairs were sown on the following dates : May 7th, May 21st and June 4th.

The results show that on the average the field germination was 360 in the case of the common variety and 420 for the giant sainfoin.

The general treatment of the plots in the seeding year, 1927, is shown in Table 1, where the dates of sowing, cutting, and average yield of green weight in lb. per drill of 24 feet are given.

The influence of early sowing is seen from the figures giving the yield of common sainfoin, where it is shown that the crop sown on April 23rd yielded 10 per cent. more produce than that sown fourteen days later on May 7th. When we consider the second and third sowings, it will be observed that the period of growth is about the same, but a great difference is to be seen in the yields. Thus the seed sown on May 7th with a period of growth of 116 days yielded 17.7 lb. per drill, while that sown fourteen days later with a period of growth of 114 days only yielded 12.1 lb. per drill, the difference in favour of the early sowing being about 40 per cent.

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[1] Malden, *Grassland Farming*, p. 29.

TABLE I.

COMMON SAINFOIN.

Date of sowing, 1927.	*Date of cutting, 1927.*	*Interval in days.*	*Average green weight in lb. per drill.*
April 23	Sept. 1	130	19.7
May 7	,, 1	116	17.7
,, 21	,, 12	114	12.1
June 4	Not cut in 1927.		

GIANT SAINFOIN.

Date of sowing, 1927.	*Date of cutting, 1927.*	*Interval in days.*	*Average green weight in lb. per drill.*
April 23	Aug. 10	109	12.5
	Nov. 9	(91)	(7.4)
May 7	Aug. 10	95	10.3
	Nov. 9	(91)	(8.2)
,, 21	Aug. 24	95	7.2
June 4	,, 29	86	8.2

In the seeding year giant sainfoin came into flower earlier than the common variety with the result that the first and second sowings were cut on August 10th. The yields from these cuts are considerably lower than those from the corresponding cuts of common sainfoin, but giant sainfoin made such rapid growth subsequent to this cutting that a second cut was taken on November 9th. The combined yield of these two cuts from the one sowing of giant sainfoin are seen to correspond closely in weight to those obtained from the one cut of common sainfoin. The third and fourth sowings were in flower and cut on August 24th and 29th, yielding 7.2 and 8.2 lb. per drill respectively.

As in the case of common sainfoin it will be seen that early sowing has a considerable influence in increasing the yield of giant sainfoin.

A well known difference between the common and giant varieties brought out in this experiment is that the giant tends to form stem and flower earlier in the seeding year. Consequently if sown early the giant variety is capable of producing stems and flowers a second time, whereas the common sainfoin may only produce one crop of flowers when sown early. There is some difference between various stocks, some of which contain a mixture of giant and common types, but the populations of the lots included in this experiment were reasonably uniform in this respect. In subsequent years, the first flowering of the two varieties is practically simultaneous, but the second flowering of giant comes sooner tending to give a second hay crop. Thus the giant is sometimes known as double cut sainfoin.

After harvesting the crop in 1927, the plots received no further treatment and were allowed to run to hay, which in 1928 was cut at different stages of maturity, its yield and chemical composition being determined.

The hay was cut at the following stages of maturity :—

Stage 1. When the flowers showed indications of opening.

Stage 2. When half of the majority of the heads showed open bloom.

Stage 3. When all the flowers had opened.

Stage 4. When flowering was over and pods were formed.

It has already been mentioned that in the first seeding year giant sainfoin flowered about a month earlier than the common variety. In the first harvest year, however, the two varieties flowered practically at the same time. The dates of cutting the hay were as follows :—

Stage 1. Common and giant—May 26th, 1928.

Stage 2. Common and giant—June 6th, 1928.

Stage 3. Common—June 14th; giant—June 15th, 1928.

Stage 4. Common and giant—July 2nd, 1928.

All four hay cuts of common sainfoin were taken from the plots sown on April 23rd, 1927, and between the first cut on May 26th, 1928, and the last cut on July 2nd, 1928, there was an interval of six weeks. In the case of giant sainfoin, however, though the different hay cuts were made up of plants at the same stage of growth, they were obtained from plots sown at different dates in 1927, the first cut only being from drills sown at the same date as the common (April 23rd, 1927).

When cut, the hays were separated into stem, leaf and flower head after being air-dried in the shed. Each separation as well as a sample of the whole plant was forwarded to Aberystwyth to be chemically examined.

In Table II, the green weight and weight of dry matter of the hay in lb. per drill of 24 feet, and the ratio of stem to leaf and to flowerhead in each cutting is given.

TABLE II.

Date of cutting hay, 1928.	COMMON SAINFOIN.			
	lb. per drill, 24 ft.		*Ratio of stem*	
	Green.	*Dry.*	*To leaf.*	*To flowerhead.*
May 26	28.0	4.6	1 : 0.8	1 : 0.12
June 6	33.0	7.6	1 : 0.56	1 : 0.28
,, 14	37.0	8.8	1 : 0.52	1 : 0.33
July 2	34.0	10.17	1 : 0.52	1 : 0.53

Date of cutting hay, 1928.	GIANT SAINFOIN.			
	lb. per drill, 24 ft.		*Ratio of stem*	
	Green.	*Dry.*	*To leaf.*	*To flowerhead.*
May 26	10.2	1.7	1 : 0.75	1 : 0.12
June 6	5.3*	1.1	1 : 0.79	1 : 0.38
,, 15	12.8	3.0	1 : 0.82	1 : 0.36
July 2	13.4	3.2	1 : 1.0	1 : 0.58

* The plant on the plot giving stage 2 of giant was very thin and small at time of cutting.

The changes in botanical characteristics generally associated with advancing maturity are better illustrated in common than giant sainfoin. Thus in the common variety the yield of dry matter increases and the ratio of stem to leaf steadily increases, and, as would be expected, the proportion of flowerhead gradually rises with age.

In giant sainfoin, though the general tendency is for the dry matter to increase, and for the ratio of stem to flowerhead to decrease with advancing maturity, these changes are not so regular as in the common variety, while the ratio of stem to leaf in giant sainfoin actually decreases with age.

The increase in the amount of leaf relative to stem in the later stages (Stages 3 and 4) of the giant hay cuts is due to the fresh growth of leaves and shoots from its base at these stages of growth, while no such fresh growth is produced by the common at these stages. Thus the stubble of the giant is readily distinguished from the common owing to the green colour of the new growth.

TABLE III.

Gives the chemical composition of the dry matter of the whole plant cut on different dates as hay, as well as that of the stem, leaf, and flowerhead that go to form that hay.

COMMON SAINFOIN (HAY).

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
Stage I. Cut on May 26, 1928.									
Stem ...	2.00	9.88	6.82	37.50	4.00	46.62	3.75	0.376	0.686
Leaf ...	4.60	21.62	17.84	17.20	6.00	50.58	5.65	0.516	1.988
Flowerhead ...	3.10	28.67	18.11	18.50	6.50	43.23	6.00	1.110	1.400
Whole plant ...	2.61	17.00	13.59	28.00	6.25	46.14	5.55	0.526	1.260
Stage II. Cut on June 6, 1928.									
Stem ...	2.10	8.22	7.38	47.12	2.70	39.86	2.30	0.286	0.758
Leaf ...	4.10	21.61	15.47	17.31	6.25	50.73	6.11	0.476	2.520
Flowerhead ...	3.00	27.38	15.75	17.25	6.25	46.12	5.90	0.968	1.344
Whole plant ...	2.85	14.96	10.59	32.00	5.25	44.94	5.00	0.486	1.400
Stage III. Cut on June 14, 1928.									
Stem ...	1.70	8.44	6.24	45.05	2.20	42.61	2.00	0.336	0.896
Leaf ...	4.20	23.01	19.05	16.35	6.35	50.09	5.65	0.486	2.842
Flowerhead ...	2.70	24.24	14.03	18.50	6.20	48.36	6.10	0.900	1.442
Whole plant ...	2.65	14.79	11.10	35.55	4.50	42.51	3.90	0.452	1.624
Stage IV. Cut on July 2, 1928.									
Stem ...	1.25	7.48	6.68	48.50	3.35	39.42	2.80	0.338	0.770
Leaf ...	3.70	20.04	16.55	17.20	8.30	50.76	7.48	0.448	3.654
Flowerhead ...	1.80	23.61	18.47	23.50	6.54	44.55	5.94	0.972	1.792
Whole plant ...	2.20	12.01	10.35	37.25	4.36	44.18	3.76	0.434	1,856

GIANT SAINFOIN (HAY).

Stage I. Cut on May 26, 1928.

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
Stem ...	2.25	10.93	7.34	35.50	3.51	47.81	2.60	0.396	0.952
Leaf ...	4.20	24.38	21.09	12.82	6.30	52.30	5.25	0.600	2.618
Flowerhead ...	2.50	28.96	13.68	18.00	6.20	44.34	6.00	1.108	1.624
Whole plant ...	3.00	18.47	14.00	27.63	6.25	44.65	4.50	0.582	1.694
Stage II. Cut on June 6, 1928.									
Stem ...	2.45	10.41	8.94	39.30	3.10	44.74	2.65	0.446	1.064
Leaf ...	4.60	26.85	21.64	13.60	7.00	47.95	6.30	0.636	3.290
Flowerhead ...	3.75	28.25	15.63	17.40	6.60	44.00	6.15	1.170	1.736
Whole plant ...	3.05	19.41	12.76	29.50	5.00	43.00	4.80	0.566	1.763
Stage III. Cut on June 15, 1928.									
Stem ...	2.15	8.40	7.08	40.25	3.40	45.80	3.10	0.356	1.092
Leaf ...	4.40	23.71	19.86	13.75	7.45	50.69	6.90	0.580	3.420
Flowerhead ...	3.15	24.15	18.71	17.11	6.60	48.99	6.21	0.988	1.582
Whole plant ...	3.20	13.71	10.11	31.60	4.51	46.98	4.15	0.522	1.652
Stage IV. Cut on July 2, 1928.									
Stem ...	1.50	8.05	6.79	43.50	5.38	41.57	4.42	0.448	1.760
Leaf ...	3.50	23.90	18.30	13.99	8.72	49.89	8.80	0.688	3.934
Flowerhead ...	2.00	22.87	18.74	24.50	7.74	42.89	6.42	1.058	2.170
Whole plant ...	2.05	15.66	11.20	33.50	6.22	42.57	5.00	0.682	2.142

On comparing the chemical composition of the whole plant of common sainfoin cut as hay at different stages of growth (see Table III), all the changes in chemical composition, accompanied by the deterioration in nutritive value generally associated with delay in cutting are seen to be illustrated. Thus the protein content falls at each successive date of cutting, while the fibre increases.

The yield of dry matter is certainly greater when the crop is cut on July 2nd than on June 14th (Table II). On the other hand, the yield of nutrients from the smaller bulk cut at the earlier date is equal to that from the larger weight cut later, and has the advantage from a nutritive point of view of containing considerably less fibre.

When the chemical composition of the different parts of the plants are compared, these are seen to differ widely one from the other, the most striking difference being found between the stem and leaf, and the stem and flowerhead. At all stages of growth the leaf and flowerhead are superior in nutritive value to the stem, being richer in protein, phosphoric acid and lime and containing a much lower percentage of fibre.

On comparing the leaf with the flowerhead, the latter at all stages of growth is richer in protein and phosphoric acid, but the leaf contains a higher percentage of lime and is generally lower in fibre.

The bearing of these differences in composition between the stem, leaf and flowerhead on the ultimate composition of the harvested crop will be realised when it is remembered how brittle the leaves and flowerheads become on drying, and how easily both are lost during harvesting operations, especially if these be conducted under unfavourable climatic conditions.

Attention has been drawn to certain differences under the conditions of the present investigation, between the two varieties of sainfoin in the character of their growth as maturity advances. In common sainfoin all those characteristics generally associated with hay cut at different stages of growth are illustrated, whereas the changes with maturity in giant sainfoin are not so regular although they show the same tendency. When the chemical composition of the hays of giant sainfoin cut at different dates are examined, these irregularities are seen to be reflected in their composition, for apart from the regular increase in fibre content with age, there is not the gradual fall in protein and phosphoric acid or the steady increase in lime that we find in common sainfoin, this, as already pointed out, being largely due to the new leaf growth at the base of giant sainfoin.

Two aftermaths of each hay of both varieties were taken, and in Table IV the yield of green and dry weight in lb. per drill of 24 feet, together with the ratio of stem to leaf in each of the aftermaths of common sainfoin are given :—

TABLE IV.

COMMON SAINFOIN.

First set of aftermaths.

Date of cutting, 1928.	*lb. per drill of 24 ft.*		*Ratio of stem to leaf.*
	Green weight.	*Dry matter.*	
July 12	9	1.5	1 : 1.9
,, 19	7	1.1	1 : 6.8
,, 25	8	1.1	1 : 5.7
Aug. 11	11	1.4	1 : 9.0

Second Set of Aftermaths.

Date of cutting, 1928.	*lb. per drill of 24 ft.*		*Ratio of stem to leaf.*
	Green weight.	*Dry matter.*	
Aug. 29	8	0.8	1 : 16
Sept. 5	10	1.0	1 : 24
,, 11	10	0.9	1 :50
,, 21	8	0.7	1 : 60

Reference to Table II shows that the first hay cut of common sainfoin was taken on May 26th, 1928, and the first aftermath from this (Table IV) on July 12th, 1928, and the second on August 29th, 1928. In the same way the second hay cut was on June 6th, and the first and second aftermath on July 19th and September 5th, 1928, respectively, the average period of growth of the different aftermaths being approximately 43 days.

Table IV shows the character of growth to be very different in the two sets of aftermaths. In the first, the ratio of stem to leaf is much higher than in the second, while the proportion of flower-heads, though not shown in Table IV, is extremely small in the first and to all intents and purposes these are absent in the second. The influence of these two factors on the chemical composition of the aftermaths is illustrated in Table V.

Taking the first set of aftermaths, Table V shows similar differences in the composition of the stem, leaf and flowerhead of the aftermath to those of the hays in Table III. The aftermaths as a whole, however, as well as their component parts, namely stem, leaf and flowerhead have all the characteristics of a younger growth. Further the stem, though not so valuable from

TABLE V.

Gives the chemical composition of the first set of four aftermaths as well as that of the stem, leaf, and flowerhead that go to form them.

COMMON SAINFOIN.

First aftermaths.

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
I. *Cut on July 12, 1928. Hay cut May 26, 1928.*									
Stem ...	2.30	10.85	7.79	36.60	4.55	45.70	4.45	0.480	0.882
Leaf ...	4.30	24.94	20.04	16.00	7.10	47.66	6.80	0.728	2.563
Flowerhead ...	3.40	25.72	17.77	16.80	7.30	46.78	7.10	1.300	1.750
Whole plant ...	3.15	19.16	14.04	26.00	6.60	45.09	6.45	0.624	1.960
II. *Cut on July 19, 1928. Hay cut June 6, 1928.*									
Stem ...	1.90	11.72	7.96	33.93	5.80	46.65	5.20	0.568	1.092
Leaf ...	3.75	22.40	18.06	16.61	8.40	47.84	7.95	0.718	2.912
Flowerhead ...	2.05	25.15	19.99	15.25	7.30	50.25	6.95	1.270	1.852
Whole plant ...	2.81	18.33	17.32	19.80	8.05	51.01	7.90	0.750	2.744
III. *Cut on July 25, 1928. Hay cut June 14, 1928.*									
Stem ...	1.90	11.89	8.83	33.80	5.10	47.31	4.70	0.544	1.092
Leaf ...	3.20	21.95	18.88	19.10	8.35	47.40	8.15	0.678	3.192
Flowerhead ...	2.85	17.32	16.01	16.80	7.95	45.08	7.40	1.058	1.708
Whole plant ...	2.95	20.47	16.45	22.45	7.05	47.08	6.85	0.624	2.660
IV. *Cut on August 11, 1928. Hay cut July 2, 1928.*									
Stem ...	1.80	13.56	8.35	38.10	6.45	40.09	5.85	0.596	1.414
Leaf ...	3.90	22.57	18.98	14.05	8.40	51.08	8.00	0.702	2.688
Flowerhead ...	2.74	26.25	17.41	17.31	7.35	46.35	7.00	1.202	1.666
Whole plant ...	3.00	22.31	16.58	18.70	7.55	47.44	7.02	0.662	2.660

COMMON SAINFOIN.

Second aftermaths.

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
I. Cut on August 29, 1928. (First aftermath cut on July 12, 1928).									
Stem ...	2.55	13.16	9.36	34.05	6.05	44.19	5.55	0.520	1.113
Leaf ...	6.95	25.93	21.32	15.00	8.95	46.17	7.10	0.658	2.387
Flowerhead ...	3.14	24.94	16.49	16.82	8.90	46.20	6.80	1.012	1.750
Whole plant ...	3.90	23.40	20.43	17.45	8.05	47.20	6.85	0.596	2.261
II. Cut on September 5, 1928. (First aftermath cut on July 19, 1928).									
Stem ...	2.00	15.03	12.60	25.15	4.05	53.77	3.85	0.552	1.428
Leaf ...	3.80	24.86	18.19	15.60	8.90	46.84	7.65	0.792	2.478
Flowerhead ...	—	—	—	—	—	—	—	—	—
Whole plant ...	3.70	22.31	15.93	19.10	8.40	46.49	7.50	0.680	2.380
III. Cut on August 29, 1928. (First aftermath cut on July 25, 1928).									
Stem ...	1.58	19.20	12.52	24.11	9.00	46.11	8.60	0.848	1.540
Leaf ...	4.95	25.93	21.44	14.15	8.30	46.67	7.50	0.762	2.520
Flowerhead ...	—	—	—	—	—	—	—	—	—
Whole plant ...	3.30	21.09	15.75	16.70	11.05	47.86	7.65	0.788	2.296
IV. Cut on September 21, 1928. (First aftermath cut on August 11, 1928).									
Stem ...	1.24	18.37	13.60	22.12	9.80	48.47	9.21	0.852	1.792
Leaf ...	4.70	25.45	20.28	13.80	8.45	47.60	7.85	0.770	2.548
Flowerhead ...	—	—	—	—	—	—	—	—	—
Whole plant ...	3.40	24.50	21.44	14.90	7.80	49.40	7.25	0.814	2.380

a nutritive point of view as the leaf or flowerhead, is superior to the stem of the hay. Again the proportion of stem to leaf being much lower in the aftermath than it is in the hay Tables II and IV, the composition of the aftermath more closely resembles that of the leaf. This is more clearly brought out in the second aftermath, where the influence of the stem on the composition of the aftermath is still less.

In Table VI, the yield of green and dry weight in lb. per drill of 24 feet, together with the ratio of stem to leaf in each of the two aftermaths of giant sainfoin are given :—

TABLE VI.

GIANT SAINFOIN.

First Set of Aftermaths.

Date of cutting, 1928.	*lb. per drill of 24 ft.*		*Ratio of stem to leaf.*
	Green weight.	*Dry matter.*	
July 11	9	1.4	1 : 0.9
,, 18	5	0.8	1 : 0.9
,, 25	11	1.8	1 : 1.1
Aug. 10	12	1.4	1 : 1.3

Second Set of Aftermaths.

Date of cutting, 1928.	*lb. per drill of 24 ft.*		*Ratio of stem to leaf.*
	Green weight.	*Dry matter.*	
Aug. 28	11	1.3	1 : 1.0
Sept. 4	7	0.8	1 : 1.6
,, 11	10	1.2	1 : 1.1
,, 21	7	0.7	1 : 8.1

On comparing Tables IV and VI, the chief difference in the character of growth of the aftermaths of the two varieties is in the higher proportion of stem to leaf in that of giant sainfoin. This difference is very striking when the second set of aftermaths of the two varieties are compared.

Another characteristic difference in the two aftermaths is the high proportion of flowerhead in the aftermath of giant sainfoin as compared with that of the common variety. On comparing the total yield of dry matter of the aftermaths of each variety there is seen to be little difference between them, that of common sainfoin being a little heavier in the first set whereas giant sainfoin is a little superior in the second.

TABLE VII.

Gives the chemical composition of the first set of four aftermaths as well as that of the stem, leaf, and flowerhead that go to form them.

GIANT SAINFOIN.

First aftermaths.

I. Cut on July 11, 1928. Hay cut May 26, 1928.

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
Stem ...	2.50	9.36	7.35	42.21	4.25	41.68	4.00	0.418	1.134
Leaf ...	4.75	25.98	19.95	12.90	8.60	47.77	8.40	0.678	3.738
Flowerhead ...	3.35	24.67	14.87	17.92	7.05	47.01	6.85	1.194	1.932
Whole plant ...	3.20	17.85	14.52	25.90	6.75	46.30	6.50	0.620	2.352
II. Cut on July 18, 1928. Hay cut June 6, 1928.									
Stem ...	1.75	9.27	7.00	39.35	4.60	45.03	4.30	0.432	1.358
Leaf ...	3.60	25.15	19.37	14.10	8.60	48.55	8.25	0.570	3.934
Flowerhead ...	3.05	24.51	13.85	18.55	7.75	46.14	7.35	1.030	1.974
Whole plant ...	3.35	20.91	15.48	22.75	7.45	45.54	6.90	0.688	2.413
III. Cut on July 25, 1928. Hay cut June 14, 1928.									
Stem ...	1.90	10.71	8.26	42.05	3.90	41.44	3.75	0.376	1.316
Leaf ...	2.65	22.31	17.81	14.50	9.85	50.69	9.60	0.562	4.536
Flowerhead ...	2.50	18.63	13.95	17.60	8.20	53.07	7.50	0.981	2.044
Whole plant ...	2.40	17.85	13.77	26.60	6.65	46.50	6.45	0.596	2.548
IV. Cut on August 10, 1928. Hay cut July 2, 1928.									
Stem ...	1.60	10.10	6.47	42.21	4.75	41.32	4.65	0.540	1.288
Leaf ...	3.70	25.89	19.55	12.05	10.15	48.21	9.85	0.628	4.368
Flowerhead ...	3.10	24.32	14.52	16.40	8.00	48.18	7.70	1.122	1.828
Whole plant ...	2.70	15.93	10.41	25.85	7.35	48.17	7.05	0.556	2.212

GIANT SAINFOIN.

Second aftermaths.

I. Cut on August 28, 1928. (First aftermath cut on July 11, 1928).

	Ether extract.	*Crude protein.*	*True protein.*	*Fibre.*	*Ash.*	*Soluble carbo-hydrates.*	*Silica-free ash.*	*Phosphoric Acid. P_2O_5.*	*Lime. CaO.*
Stem ...	2.35	11.20	7.65	45.05	4.35	37.05	3.95	0.400	1.106
Leaf ...	3.75	25.41	19.45	14.55	10.85	45.44	9.60	0.641	3.486
Flowerhead ...	3.35	23.74	14.99	18.00	9.65	45.26	7.45	1.010	1.512
Whole plant ...	3.05	18.87	14.04	26.80	7.10	44.18	6.10	0.596	2.107
II. Cut on September 4, 1928. (First aftermath cut on July 18, 1928).									
Stem ...	2.40	10.27	7.26	42.95	5.10	39.28	4.75	0.436	1.204
Leaf ...	3.60	26.69	20.38	12.40	11.05	46.26	9.55	0.908	3.668
Flowerhead ...	3.10	25.98	15.87	18.50	8.15	44.27	7.35	1.150	1.736
Whole plant ...	3.10	20.83	16.35	18.20	11.45	46.42	7.20	0.784	2.828
III. Cut on September 11, 1928. (First aftermath cut on July 25, 1928).									
Stem ...	1.65	11.81	7.44	38.70	6.30	41.54	6.10	0.492	1.540
Leaf ...	4.10	27.20	20.38	13.30	9.45	45.95	8.70	0.746	2.884
Flowerhead ...	3.30	25.80	—	17.95	8.15	—	7.95	1.174	1.848
Whole plant ...	3.50	22.70	16.01	20.50	8.20	45.10	7.40	0.714	2.352
IV. Cut on September 21, 1928. (First aftermath cut on August 10, 1928).									
Stem ...	2.00	14.30	9.36	31.50	8.10	44.10	7.65	0.768	1.764
Leaf ...	4.00	26.25	21.17	14.12	8.15	47.48	7.60	0.796	2.464
Flowerhead ...	2.51	23.88	19.07	16.61	7.75	49.25	7.40	1.136	1.998
Whole plant ...	2.60	23.26	17.58	17.30	8.40	48.44	7.85	0.756	—

On comparing the yield of the two sets of aftermaths of the two varieties, the difference between them is seen in Tables IV and VI to be small and very slightly in favour of giant sainfoin.

The chemical composition (Table VII), on the other hand, shows the aftermath of common sainfoin to be slightly superior in protein content and to contain a lower percentage of fibre. The difference, however, in chemical composition is not as pronounced as would be expected when the ratio of stem to leaf in the two sets of aftermaths are taken into consideration.

The results generally go to confirm the work previously carried out at Aberystwyth with the hay and aftermath of grasses namely that :—

1. The earlier the hay is cut the more nutritious it is in consequence.
2. Delay in cutting results in a greater yield of produce, but the quality is inferior.
3. Comparison of the chemical composition of the four sets of hays of common sainfoin cut at succeeding dates illustrate the deterioration that takes place with delay in cutting. Thus there is a fall in the protein content accompanied by a rise in fibre.
4. The leaf of sainfoin is much higher in nutritive value than the stem, and the proportion of stem to leaf in the hay has a very considerable influence on its nutritive value.
5. The chemical composition of the aftermaths show all the characteristics of a young leafy growth.

THE CHEMICAL COMPOSITION OF BARLEY GRAIN AND STRAW GROWN IN MID-WALES.

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Attention was drawn to the necessity for investigation into the chemical composition of home-grown foods in an earlier volume of the *Journal*, in which a paper appeared giving the chemical composition of mangolds grown in Mid-Wales.[1] The present paper is in continuation of this work and embodies the result of an investigation into the chemical composition of the grain and straw of barley grown in Mid-Wales.

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[1] " The chemical composition of mangold grown in Mid-Wales ". Fagan and Watkin. *Welsh Journ. Agric.*, Vol. IV, p. 102.

The typical barley land of the area consists of a narrow belt running along the coast line and extending from Pembrokeshire in the south to Merionethshire in the north. This land from early times has been noted for its barley, and there is ample evidence to show that it was held in high esteem for the growing of this cereal by the early writers. Thus Lloyd and Turner in 1794 state that " barley was continuously grown on it for the last sixty years ", and Gwallter Mechain in 1814 adds that " perpetual barley manured with tang or seaweed without any alternating crop has been grown upon it ", and further that " it ripened fully three weeks earlier than the neighbours who are only half a mile away on rising ground. "

During the last ten years there has been a steady reduction in the area devoted to barley in Wales, the area under the crop in 1928 being less than half that of 1918. Further, of the total acreage in 1928, nearly a half of this was confined to the counties of Pembrokeshire and Cardiganshire.

The greater part of the barley grown is used for stock feeding, that grown for malting being in comparison almost negligible. It is of interest to note that a small amount is still used for human consumption, for in certain parts of the country there appears to be a slight revival of the old custom of incorporating barley with wheat flour for baking into bread. In the main, however, it is grown as a source of concentrated food and fed to pigs and cattle.

Store pigs in many districts are fed with a mixture of oats and barley, the proportion of oats being lowered and that of barley raised as the pigs advance towards the fattening period. Where barley is grown in fair quantity, the winter fattening of pigs is often accomplished with this cereal to which for bulk potatoes are added. Barley is also often fed to dairy cattle as a constituent of the concentrates which at times is almost wholly composed of home grown foods. This has led to many farmers growing a mixture of oats and barley that goes under the name of " Sipris ".

Similarly barley makes up a part of the mixture of concentrates fed to fattening cattle. Again small quantities are fed to horses, the barley previously soaked in water being fed to those horses which for some reason or other it is desirable to treat a little better than others.

The straw of barley is considered inferior in feeding value to oat straw, but it has to be remembered that barley straw as produced in Wales is of rather exceptional character, in that it contains a fair amount of bottom growth—grass and clover, which it obtains from the young seeds as a result of being used as a nurse crop. The proportion of this bottom growth in the straw is also likely to be considerably greater in Wales than in the arable districts of England, owing to the soil and climate being more favourable to its growth in the first year. The result is that barley straw as consumed in Wales is better value than what it is generally credited to be. Many farmers use barley and oat straw indiscriminately for cattle and horses, though in some districts it is the custom to chaff the barley straw for the horses and reserve the oat straw for the cattle.

The samples dealt with in this paper have been collected during the course of the last six years, and may be taken as representative of the crop grown on a variety of soils at altitudes varying from sea level to 700 feet—some of the samples were grown on experimental plots, but the majority were grown under ordinary farming conditions. The necessity under our conditions with the improved varieties of a frequent change of seed, makes the number of varieties examined fairly representative of those generally grown. A variety still grown in many parts of Wales is Hen Gymro, for its straw is considered to be superior in feeding value, and under the varying conditions of soil and season in the area it is considered to be more consistent as a cropper.

In the following Table the average yield of dry matter of the grain and straw of barley for the area are shown, and for comparison that of the same varieties when grown on the typical barley land.

TABLE I.

Average yield per acre for the area in cwt. per acre dry matter.		*Average yield per acre on the typical barley land, in cwt. per acre dry matter.*	
Grain.	Straw.	Grain.	Straw.
12.5	22	14.5	24.5

The above Table has been prepared from the results of a large number of experiments on the growing of barley in Mid-Wales, and from carefully kept records where the crop has been grown under ordinary farming conditions.

It should be pointed out that owing to the difficulty experienced in obtaining records of the crop grown at higher altitudes than 700 feet and their consequent omission, the average yield per acre given in the Table are slightly higher than those published in the Ministry of Agriculture returns.

The Table shows that on land suited to its cultivation in the area, crops of barley can be grown equal both in yield of grain and straw to those obtained in most parts of Britain. In our climate with its heavy rainfall the raising of such crops is, however, accompanied with the risk of their becoming lodged.

As previously mentioned, the greater part of the barley grown in Wales is used for feeding purposes. It is consequently of the highest importance to know, both from the point of view of economy and the well being of our stock, how it compares in composition with the average generally taken.

In Table II the average percentage composition of the dry matter of the grain of barley grown in Mid-Wales is given and for comparison the average generally taken.

TABLE II.

	Average percentage composition of dry matter of grain grown in Mid-Wales.	*Average composition generally taken.*
Oil ...	2.02	2.18
Albuminoids ...	10.01	12.88
Fibre ...	5.51	5.30
Ash ...	2.37	3.05
Soluble carbohydrates	80.09	76.59
Silica-free ash ...	2.00	1.86
Phosphoric acid (P_2O_5) ..	0.73	0.94
Lime (CaO) ...	0.06	0.07

On comparison, the average percentage of some of the constituents determined in the dry matter of the grain grown in Mid-Wales, for example oil and fibre, is seen to differ very little from the average generally taken. In albuminoids and phosphoric acid content, however, both of which have important functions to perform in animal nutrition, there is an appreciable difference. Thus in albuminoids there is a difference of 28 per cent. and in phosphoric acid 22 per cent. in favour of the average figures generally taken. In a suitable season, however, the grain grown on the typical barley land of Mid-Wales compares favourably both in yield and chemical composition with that grown in other parts of Britain.

The percentage of dry matter in the grain grown at a particular centre shows little variation from one variety to another, but when these are grown at different centres the variation from one centre to another as shown in Table III is quite marked.

Centre 1 is on the coastal belt, 2 is further inland and not such good soil, 3 is at a little higher altitude with a soil very similar to 2.

TABLE III.

Showing the percentage of dry matter in the same varieties of barley grown at three different centres.

Variety.	*1*	*2*	*3*
Standwell ...	88.72	87.75	85.66
Primus ...	88.45	87.60	85.07
Plumage Archer ..	88.23	87.49	85.19
1917 ...	88.67	87.59	85.01
Malster ...	88.78	87.59	84.79
Bere (Scotch) ...	88.56	88.08	85.34
Bere (Welsh) ...	88.41	—	85.38
Brio ...	88.47	87.36	85.04

Generally speaking, the grain with the highest percentage of dry matter is raised on the best land, namely the coastal belt, where the average of a large number of samples grown during the last six years has been slightly over 88 per cent. Samples grown further inland and at moderately high elevations closely approach these in their percentage of dry matter, but such a number of them had been harvested under unfavourable conditions that on storage they had obviously become somewhat heated, which probably accounts for their low moisture content. That there is considerable room for error in building up rations when average figures for a whole country or even for a smaller area such as Mid-Wales are taken is shown in Table IV, and emphasises the necessity if reasonable accuracy is to be attained of knowing the composition of the crops raised in different localities.

TABLE IV.

Gives the range of variation found in the percentage composition of the dry matter of the barley grain grown in Mid-Wales.

Oil.		*Albuminoids.*		*Phosphoric Acid.*		*Lime.*	
Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*
1.42	2.33	8.65	12.24	0.511	0.872	0.05	0.089

The above Table shows that the chemical composition of the grain is subject to wide variation, and on comparing the maximum percentages found in the grain grown in Mid-Wales with the average generally taken, Tables II and IV, it is the albuminoids or protein and phosphoric acid content that are seen to be low, for in no sample examined has the percentage of these constituents reached that of this average. The maximum percentage of oil and lime on the other hand are slightly higher.

The percentage of ether extract or oil in the dry matter of the grain varies considerably, there being a difference of over 60 per cent. between the minimum and maximum in the samples under consideration. This variation is due to locality where grown more than to variety. The average percentage of ether extract in the grain grown on the better land was if anything a little lower than in samples from further inland. In this connection, however, it has to be remembered that under the heading ether extract other substances than oil are often included. Thus if samples are less mature or not very clean the tendency is for the ether extract to be high.

A difference of 40 per cent. between the minimum and maximum percentage of albuminoids or protein content of the samples examined was met with. This variation is largely dependent upon the variety, soil and altitude at which the crop is grown. The effect of each of these factors is quite pronounced, though of the three, variety appears to have the greatest influence. Experimental work carried out in the counties confirm the results obtained with the crop grown under ordinary farming conditions, namely, that the richest grain in albuminoids or protein is that grown on the coastal belt, which on the average contains 11 per cent. Further inland the soil in the majority of cases is not so well suited to the crop, and as a few miles distance from the coast often means a considerable increase in altitude, both these factors adversely influence the composition of the grain, with the result that the average percentage of albuminoids falls to approximately 9 per cent.

The average fibre content of the barley grain is 5.5 per cent., a figure slightly lower than that given for average feeding barley. The fibre compared with other constituents of the grain does not show such wide variation from district to district, though the barley grown on the best land is slightly higher in fibre than that grown inland. When, however, the percentage of fibre in the different varieties are compared it will be seen that they show considerable variation.

The soluble carbohydrates, which in barley consists mainly of starch, makes up approximately 80 per cent. of the dry matter.

The percentage of silica-free ash in the grain grown on the better barley land is on the average 10 per cent. higher than that from other localities. The grain grown inland is on the whole low in silica-free ash and the percentage present is not subject to any very wide variation. Of the ash constituents determined, the most important and the one present in largest quantity is phosphoric acid, forming approximately one-third of the total ash. The percentage of phosphoric acid varies in rather an irregular manner, but on the average the dry matter of the grain grown on the best land is highest, while that from the less suitable situations further inland is lowest.

As in the case of all grain the lime content is low, and only amounts to about one-tenth of the phosphoric acid.

The average percentage composition of the dry matter of the grain of different varieties of barley grown in Mid-Wales is given in Table V. The samples being grown under experimental and ordinary farming conditions in which the latter predominate.

TABLE V.

The average percentage composition of the dry matter of the grain of ten varieties of barley grown in Mid-Wales.

	Oil.	*Albuminoids crude.*	*Albuminoids true.*	*Fibre.*	*Ash.*	*Soluble Carbohydrates.*
Standwell ...	2.18	9.89	9.51	4.80	2.20	80.93
Plumage Archer	2.05	9.14	8.14	5.26	2.34	81.21
Archer ...	2.00	9.71	8.28	4.62	2.14	81.50
Malster ...	2.11	9.59	9.01	5.05	2.85	80.90
Primus ...	2.15	10.26	9.60	4.98	2.20	80.41
Gartons 1917 ...	2.16	10.74	9.62	5.11	2.71	79.15
Brio ...	1.99	10.02	9.42	5.75	2.42	79.82
Bere Welsh ...	2.10	10.92	10.51	6.06	2.58	78.34
Bere Scotch ...	2.21	11.44	10.65	5.81	2.22	78.82
Hen Gymro ...	2.23	11.56	10.60	6.12	2.65	77.44

	Silica-free ash.	*Silica SiO_2.*	*Phosphoric acid. P_2O_5.*	*Lime CaO.*	*Chlorine. Cl.*	*Iron. F_2O_3.*
Standwell ...	1.98	0.22	0.720	0.063	0.022	0.006
Plumage Archer	1.98	0.36	0.727	0.068	0.033	0.009
Archer ...	1.84	0.30	0.603	0.054	0.017	0.007
Malster ...	2.05	0.30	0.768	0.070	0.020	0.007
Primus ...	1.95	0.25	0.665	0.056	0.018	0.006
Gartons 1917 ...	2.36	0.35	0.836	0.063	0.014	0.006
Brio ...	2.11	0.31	0.727	0.063	0.019	0.006
Bere Welsh ...	2.28	0.35	0.700	0.069	0.019	0.009
Bere Scotch ...	1.98	0.29	0.664	0.079	0.019	0.005
Hen Gymro ...	2.28	0.42	0.712	0.071	0.020	0.008

Of the varieties examined, the dry matter of Hen Gymro, Scotch Bere, and Welsh Bere contain the highest percentage of albuminoids. These contain on the average 11 to 11.5 per cent. A second group is composed of Brio, Primus and Garton's 1917, with from 10 to 10.75 per cent., while Plumage Archer, Malster, Archer and Standwell form a third group, with from 9 to 10 per cent. The average percentage of albuminoids in all the samples is approximately 10, a figure in close agreement with that given by Wood[2] for feeding barley.

The percentage of crude fibre shows quite an appreciable variation. Hen Gymro, Scotch and Welsh Bere being higher in fibre than any of the other varieties, while Archer, closely followed by Standwell, Primus and Malster, is the lowest.

In silica-free ash, Garton's 1917 is consistently high, as are also Hen Gymro and Welsh Bere. The Scotch variety ,of Bere and Archer on the other hand are among the lowest in this constituent.

The phosphoric acid content, as already mentioned, varies with the locality where grown, and of the varieties dealt with Welsh Bere shows the influence of this factor better than any other. For when this variety is grown near the coast it is amongst the richest in phosphoric acid, but when grown further inland it is very low. Of all the varieties, Garton's 1917 is highest in phosphoric acid, Malster also being relatively rich in this constituent. Archer, Scotch Bere, and Primus are on the average poor, but are not consistently so throughout the area.

Chemical composition of barley straw.

The average percentage composition of the dry matter of all the straws examined is given in Table VI, and for comparison the average generally taken.

TABLE VI.

	Average percentage composition of dry matter of straw grown in Mid-Wales.	*Average composition generally taken.*
Oil ..	1.82	2.09
Albuminoids ...	2.87	3.83
Fibre ...	45.74	39.53
Ash ...	4.74	5.35
Soluble corbohydrates	44.83	49.20
Silica-free ash ...	3.34	2.36
Phosphoric acid (P_2O_5) ...	0.147	0.232
Lime (CaO) ...	0.479	0.580

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[2] "Rations for Live Stock ". Wood, T. B. (Miscellaneous Publications, No. 32, Ministry of Agriculture and Fisheries, 1923).

From the Table it is seen that the straw grown in Mid-Wales is poorer in oil or ether extract, albuminoids, phosphoric acid and lime, but higher in silica-free ash and much higher in fibre. The difference in fibre content is very striking, and is on the whole contrary to what would be expected in a cereal grown in a climate such as that of Mid-Wales. Nevertheless, in no variety examined or in any sample of a variety does the fibre content of the dry matter of the straw fall below 41 per cent. The composition of the dry matter of the straw, as was the case with the grain, is subject to considerable variation. The range of variation in oil, albuminoids or protein, phosphoric acid and lime is given in Table VII.

TABLE VII.

Oil.		*Albuminoids.*		*Phosphoric acid.*		*Lime.*	
Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*
1.45	2.33	2.14	4.69	0.101	0.230	0.302	0.744

The percentage of the various constituents shown in the above Table are seen to vary within wider limits in the straw than in the grain, and the maximum percentage of each of these constituents equal and in cases exceed the average generally taken.

The barley straw grown in Mid-Wales is generally low in albuminoids or protein content and with the exception of that grown on the best barley land is much lower than 4 per cent., the average figure generally given. It is, as seen in Table V, subject to considerable variation being influenced both by variety and the locality where grown. This variation among the varieties is more striking when these are grown on the best land, the richest containing over 40 per cent. more albuminoids or protein than the poorest. The influence of locality on the albuminoid content of the straw is similar to that on the grain, the straw grown on the best barley land being much richer than that grown further inland. Thus the average percentage of a number of the same variety grown on the best land was 3.75, whereas the same variety grown further inland had an average of but 2.28 per cent.

As already mentioned, the average percentage of fibre in the straw is higher than that generally given, while some varieties are consistently higher in their fibre content than others.

The principal cause of variation with some varieties is the locality where they are grown, though this appears to have little, if any, influence on others. In the case of those varieties whose fibre content are influenced by locality, it is found to be lower when these are grown on the better land near the coast than when grown further inland.

The dry matter of the straw is richer in silica-free ash than the grain, and on the land along the coast the average percentage is much higher than in that grown further inland. The phosphoric acid content is but approximately a fifth of that present in the grain, and on the average constitutes 3 per cent. of the ash. It shows considerable variation among the varieties and is also influenced by the locality where grown. The straw from the better land is consistently high in phosphoric acid with an average of 0.187 per cent., while that grown well inland is consistently low with an average of 0.116 per cent.

The iron content of the straw, though much higher than the grain, is low in all varieties. Among the most important constituents determined in the ash are lime and chlorine, both of which are present in greater amounts in the straw than the grain. The average lime content of the straws examined compares favourably with the average generally given, and forms approximately 10 per cent. of the total ash, being higher in the straws grown inland than in those grown on the better land along the coast. Of the ash constituents determined, chlorine shows the widest variation, and it is of interest to note that proximity to the sea has, as is shown in the following Table, a very decided influence on the amount present.

TABLE VIII.

Gives the percentage of chlorine present in the dry matter of barley straw grown at varying distances from the sea.

Distance from sea in miles (approximately). ...	1	20	30
Percentage of chlorine in dry matter of straw ...	0.68	0.332	0.264

Thus the average chlorine content of the dry matter of the straw grown on the sea coast forms 14.2 per cent. of the total ash, while in the straw grown in localities further from the sea it forms 7.7 per cent.

In Table IX, the average composition of a number of barley straws is given. These varieties of straw correspond to those of the grain already referred to, and it should be pointed out that they represent the composition of the straw alone and not that of a mixture of straw and bottom growth.

On comparing the average percentage composition of the straw of different varieties, these are seen to vary among themselves, though not very widely. Thus Brio, Hen Gymro, and Welsh Bere are the richest in ether extract or oil, while Garton's 1917 is amongst the poorest in this constituent. Garton's 1917, however, is the richest in albuminoids or protein, closely followed by Hen Gymro and Plumage Archer, while Primus and Standwell are among the lowest. All the straws are high in their percentage of crude fibre, which varies in the different varieties from 45 to 48 per cent. The straw of Standwell is particularly high in fibre, being one of those varieties in which locality where grown appears to have little influence on the percentage of this constituent.

TABLE IX.

The average percentage composition of the dry matter of the straw of ten varieties of barley grown in Mid-Wales.

	Oil.	*Albuminoids crude.*	*Albuminoids true.*	*Fibre.*	*Ash.*	*Soluble Carbohydrates.*
Standwell ...	1.80	2.71	2.54	48.32	4.66	42.51
Plumage Archer	1.86	3.18	2.97	45.00	4.91	45.05
Archer ...	1.74	2.80	2.56	46.11	4.87	44.48
Malster ...	1.62	2.75	2.61	46.09	4.59	44.95
Primus ...	1.81	2.66	2.49	45.33	4.40	45.80
Gartons 1917 ...	1.41	3.28	3.06	45.11	4.98	45.22
Brio ...	1.99	2.81	2.66	45.81	4.62	44.77
Bere (Welsh) ...	1.87	2.99	2.79	45.33	4.79	45.02
Bere (Scotch) ...	1.75	2.82	2.68	44.98	5.02	45.43
Hen Gymro ...	1.89	3.21	2.84	46.02	5.22	43.66

	Silica-free ash.	*Silica* SiO_2.	*Phosphoric acid.* P_2O_5.	*Lime* CaO.	*Chlorine.* Cl.	*Iron.* F_2O_3.
Standwell ...	3.52	1.14	0.141	0.513	0.108	0.019
Plumage Archer	3.39	1.52	0.147	0.474	0.424	0.023
Archer ...	3.31	1.56	0.128	0.452	0.481	0.024
Malster ...	3.39	1.20	0.151	0.488	0.463	0.025
Primus ...	3.14	1.26	0.134	0.427	0.410	0.027
Gartons 1917 ...	3.51	1.47	0.174	0.445	0.510	0.025
Brio ...	3.38	1.24	0.188	0.503	0.648	0.023
Bere (Welsh) ...	3.44	1.85	0.160	0.464	0.443	0.023
Bere (Scotch) ...	3.68	1.84	0.126	0.517	0.507	0.028
Hen Gymro ...	3.50	1.72	0.138	0.520	0.468	0.029

With regard to the mineral content of the straws, more particularly the phosphoric acid and lime, broadly speaking it may be said that those varieties in which the grain are rich in these constituents have straws correspondingly rich and vice versa. Thus the straws of Garton's 1917, Welsh Bere and Malster are richest in phosphoric acid, while Archer, Scotch Bere and Primus are poorest. Similarly Hen Gymro and Scotch Bere as in the grain have straws with the highest percentage of lime.

It has already been mentioned that barley straw as produced in Mid-Wales is fairly rich in bottom growth, the presence of which adds very materially to its feeding value. That the composition of the straw with and without this bottom growth differ in important particulars is seen in Table X.

TABLE X.

Showing the composition of the dry matter of the mixture of barley straw and bottom growth and for comparison the barley straw alone.

	Straw with bottom growth.	*The straw alone.*
Oil ...	2.81	1.76
Albuminoids ...	4.42	2.70
Fibre ...	37.98	45.23
Ash ...	5.39	4.07
Soluble carbohydrates	49.40	46.24
Silica-free ash ...	4.04	3.00
Phosphoric acid (P_2O_5) ...	0.285	0.119
Lime (CaO) ...	0.621	0.461

The removal of the grasses and clovers, as would be expected, affects each of the constituents determined. For it lowers the percentage of ether extract or oil, albuminoids and carbohydrates, and increases the percentage of fibre. Thus the nutritive value of the straw has been rendered inferior in every way, whether it be considered from the point of view of mineral matter content, protein supply or starch equivalent.

Conclusions.

1. In suitable seasons, the crop grown on the best barley land in Mid-Wales compares favourably both in yield and chemical composition of grain and straw with that grown in other parts of Britain.
2. Soil, altitude and the variety grown affect the percentage of the different constituents determined in both grain and straw.
3. The wide variation in chemical composition of the grain

grown in the area emphasises the necessity, if reasonable accuracy is to be attained in building up rations, of a more accurate knowledge of its composition grown in different localities.

4. The feeding value of the dry matter of the straw as shown by its chemical composition is very appreciably affected by the quantity of bottom growth it contains.
5. The chlorine content of the dry matter of the straw is shown to be influenced by proximity to the sea.

We desire to express our thanks to Mr. Moses Griffith, M.Sc., the County Agricultural Organiser for Merionethshire, to Professor Griffith, B.Sc., and Mr. R. Phillips, M.Sc., as well as many others for the facilities they afforded us in taking samples and supplying much of the data incorporated in the paper.

SOIL SURVEY OF WALES.

PROGRESS REPORT, 1927-9.

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Since the publication of the last report (this *Journal*, Vol. IV, 1928) considerable progress has been made both in the extent of the ground covered and also in the methods of classification and mapping. As the modifications in method affect the presentation of the collected data, it will be convenient to devote some space to a statement and discussion of the principles underlying our work.

It has been our aim since the beginning of the work to ensure that all data relevant to agricultural conditions should be collected and recorded on the six-inch maps which form the base maps of the survey. For convenience of statement, however, it is desirable to devise some system whereby the facts which we collect can be reduced to an orderly arrangement. In other words it is necessary to have a system of classification for our soils.

After much consideration, we have provisionally adopted a method of classification which resembles in many respects that in use in the United States Soil Survey. Briefly, the underlying consideration is that the character of soils is determined both by the nature of the parent material and also by the methods of formation, and in order to secure the best grouping of the observed facts we arrange our soils into series, each consisting of a set of soils derived from the same or similar parent material under the same conditions of formation, showing a general similarity in the soil profile, *i.e.*, in the vertical succession of horizons, and only differing among themselves in texture. Each series, following the American practice, is named after the locality where it is first studied or where it attains its most extensive development. For example, the Monmouth series consists of sedentary soils derived from Old Red Sandstone material under conditions of free drainage. A certain texture range is observable in the series and we thus have such types as the Monmouth Pebbly Light Loam and the Monmouth Silty Loam. The corresponding soils derived from drift material form the Castleton series, and the soils derived from Old Red Drifts with impeded drainage form the Frog Moor series.

It should be emphasised that the classification now used is provisional, because it is hoped that an agreed system for the whole of Great Britain will eventually be devised and so, whilst our system is adequate for Welsh conditions, it may be necessary to introduce modifications for the sake of securing uniformity of procedure amongst soil surveyors in all parts of the country.

The following series occur in the areas with which we deal in the present paper. For convenience of statement we have grouped them together into " suites ", each suite comprising soils derived from the same or similar geological material and yielding its different series by variations in the mode of occurrence and formation of the constituent soils.

Bangor suite.

Parent material. Igneous and pyroclastic rocks (*e.g.*, volcanic ashes), together with the hard grits of Cambrian and Ordovician age, which resemble the igneous rocks in their structure.

Bangor series (B). These are sedentary soils developed under conditions of free drainage. The parent rock is fairly resistant to weathering and the profile is, in consequence, often shallow. Profiles show a variable depth of warm brown to reddish brown light stony loam passing gradually into a rather heavier and more compact stony subsoil. The nature of the parent material introduces some variations in the texture.

Ebenezer series (B_1). These are drift soils corresponding with the Bangor series and different types may be distinguished according to the nature of the drift, whether boulder clay, sands and gravels, or hillwash. The commonest type is a dull brown light loam over a heavier yellowish or reddish brown subsoil.

Sion series (B_2). Derived from Bangor drift material under conditions of impeded drainage. Two degrees of wetness may be distinguished, namely the Sion A series which is subject to seasonal wetness, lying commonly on slopes and to some extent improved, and the Sion B series which is permanently wet, occurring in valley bottoms under a poor rushy herbage often with local peat formation. Both series yield greyish or brownish grey soils over heavy greyish mottled subsoils.

Powys suite.

Parent material. Non-calcareous sedimentary rocks, and their drifts, of Cambrian, Ordovician, and Silurian age. Crystalline hard grits of the Cambrian and Ordovician are excluded because they resemble more nearly the igneous rocks as soil formers, and are included with the Bangor suite.

Powys series (P). Sedentary soils developed with free drainage. Generally occurring in rolling upland country such as is typical of mid-Wales. Generally dull brownish shaly loams over yellowish brown or orange brown subsoils. Texture varies somewhat and is often dominated by the presence of shaly material which is so characteristic of this suite.

Penrhyn series (P_1). Developed from Powys drift material under conditions of free drainage. Typically a brown or slightly greyish brown soil with a varying content of shale, differing from the Powys mainly by its greater depth. Variations from the typical Penrhyn are introduced by admixtures of other parent materials.

Cegin series (P_2). Derived from Powys drift under conditions of impeded drainage. Greyish loams with the typical profile of badly drained soils. This series may be subdivided according to the degree of wetness in the same way as the Sion series of the Bangor suite.

Conway series (P_3). Alluvial soils of the Bangor suite. Resemble in many respects the Cegin series, but occur in flat bottoms along rivers. Considerable texture variation is encountered.

Monmouth suite.

Parent material. Old Red Sandstone sedimentary rocks, and their derived drifts.

Monmouth series (M). Sedentary soils derived under conditions of free drainage. Variations in texture introduced by character of parent rock. Quartz conglomerate produces a light pebbly loam occurring in marked features. Sandstones and marls produce heavier soils occurring generally on smooth rounded hills.

Profile consists of reddish brown soil over a brighter coloured subsoil.

Castleton series (M_1). The corresponding drift soils. Differ from the Monmouth series by their greater depth.

From Moor series (M_2). A series of drift soils characterised by impeded drainage.

Gower suite.

Parent material. Carboniferous Limestone and derived drifts.

Gower series (G). Sedentary soils derived under conditions of free drainage. Chocolate brown or reddish brown light loams. The thin upland phase is generally subject to drought and only useful for sheep grazing. The deeper lowland phase is generally fertile.

Pentraeth series (G_1). Drift soils corresponding with the Gower series. Reddish brown loams of considerable depth and fertility.

Neath suite.

Parent material. Non-calcareous Carboniferous sediments, including Millstone Grit, Coal Measure Sandstones and Shales, and Red Measures.

Neath series (N). Dull brown loams of variable texture over yellowish brown subsoils. The Parciau series of Caernarvonshire has been separated because of its warm red colour, which is quite distinct from the dull colour of typical Neath soils.

Ilston series (N_1). Drift soils of the Neath suite developed with free drainage. Resemble the Neath series.

Pengwern series (N_2). Neath drift with impeded drainage.

In addition there are series derived from mixed drift which appear to be sufficiently well defined to be separated. Such for example are the Stouthall (M_1G_1), Oldwalls ($M_1G_1N_1$) and Murton (N_1G_1) series of Gower, which are formed from mixtures of Monmouth, Gower and Neath material.

Gower Peninsula.

Approximately 70 square miles, comprising the greater part of the peninsula, have been surveyed, and the types shown in the accompanying map are representative of the whole of Gower.

With the exception of the upstanding ridges formed of Old Red Sandstone Conglomerate, this area forms generally a rolling plain with an altitude of about 250 feet. Rivers are, as may be expected, small and insignificant and the small total area of river alluvium consists of narrow strips of soil showing impeded drainage.

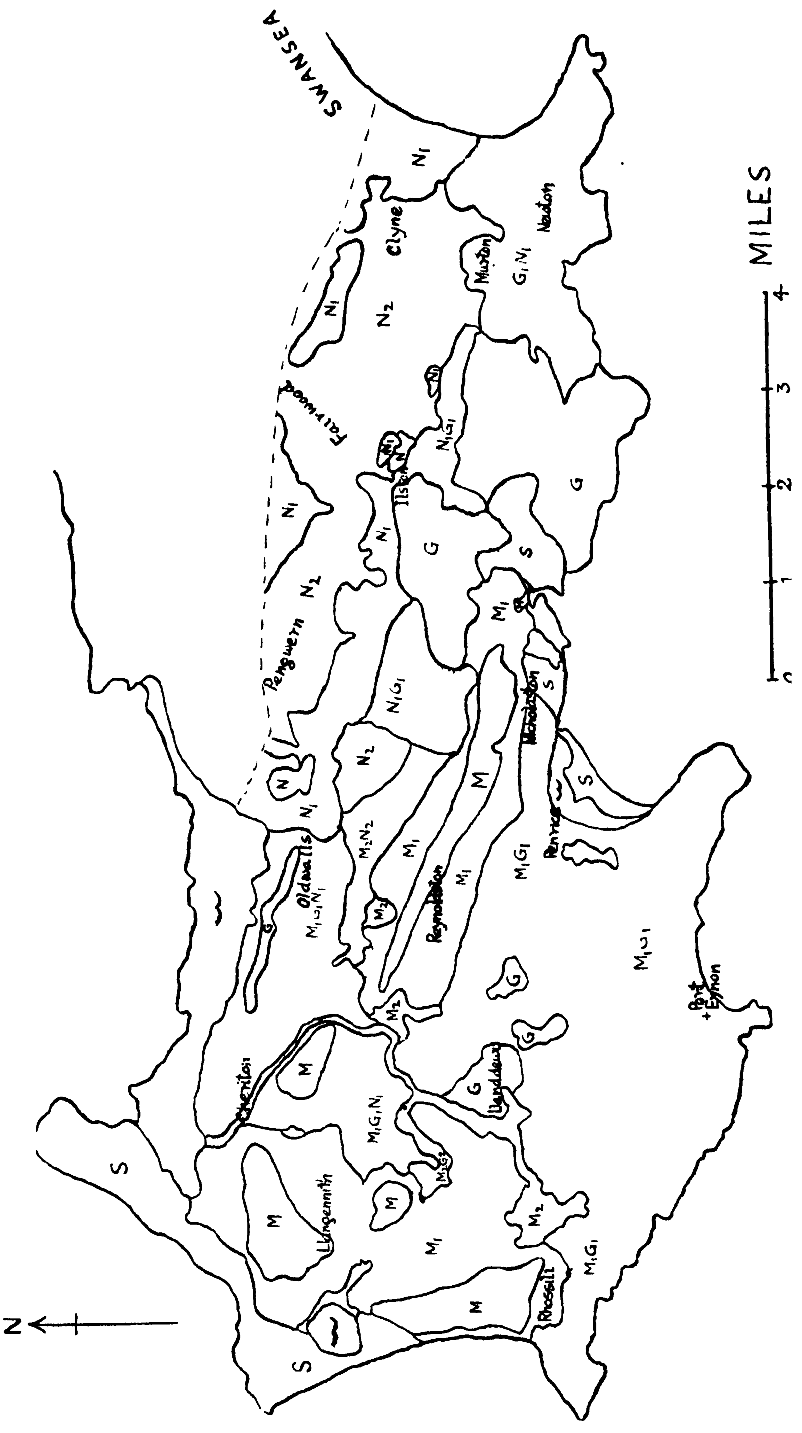

FIG. 1. GOWER PENINSULA.

The area is underlain by rocks belonging to two systems, namely, the Old Red Sandstone and the Carboniferous. There are two small patches of Silurian rocks, but as these are obscured by drift, they do not contribute to the soil map.

The Old Red Sandstone in this area is represented by a coarse quartz conglomerate. This is the parent rock of the local Monmouth series and also, as glacial drift, of the Castleton series.

The Carboniferous Limestone and the non-calcareous Carboniferous sediments, shales and grits, give rise to two distinct suites, namely, the Gower and the Neath respectively.

The following types have been recognised :—

	Series.	*Types.*
Monmouth suite	Monmouth (M)	Pebbly Light Loam.
	Castleton (M_1)	Pebbly Light Loam.
	Frog Moor (M_2)	Medium Loam.
Gower suite	Gower (G)	Light Loam.
	Pentraeth (G_1)	Light Loam.
Neath suite	Neath (N)	Medium Loam. Light Loam.
	Ilston (N_1)	Medium Loam.
	Pengwern (N_2)	Medium Loam.

In addition, the drifts provide soils of mixed origin which are somewhat difficult to classify. They have been grouped into three special series, though it should be emphasised that, as is generally the case with mixed drifts, it is not possible to draw hard and fast boundary lines. Each of these mixed series is developed under conditions of free drainage. The Stouthall is formed of mixed Monmouth and Gower material, the Murton series of mixed Neath and Gower material, and the Oldwalls series of mixed material from the three formations which are found in the area.

Coming now to the description of the actual types as they occur in Gower, it is to be noted that the Monmouth Pebbly Light Loam generally occupies the tops of fairly steep hills. The profile is usually shallow and open in texture, and characterised by a high proportion of quartz pebbles. This condition, together with the natural facility of drainage, permits strong leaching and consequent impoverishment. The soils are generally in rough grazing under a poor vegetation of inferior grasses and bracken. In some places the impoverishment has proceeded sufficiently for the development of the bleached layer characteristic of a podsol profile.

The drift phase of the Monmouth suite in this area is represented by the Castleton Pebbly Light Loam. These soils are normally deep and free working and provide some of the best agricultural land of the district. The mechanical analysis shows a well balanced texture with fine sand as the dominant fraction, but the presence of quartz pebbles, not shown in the analysis, gives a light open character to the soil. The figures for exchangeable lime and the reaction figures indicate a shortage of lime which is probably characteristic of the series as a whole.

There is no great extent of the Frog Moor Medium Loam, which is characterised by impeded drainage. The areas of this type are rushy and of inferior value.

The Gower Light Loam occurs in this area as a lowland soil. It is fertile and of fair depth. A shallow upland phase also occurs to a small extent. The corresponding drift series is the Pentraeth, which is in this area a light loam similar to the Gower but of greater depth.

In the Neath series there are two textural types. The Neath Medium Loam, derived from Carboniferous shales, occurs in small patches. The analytical figures show these soils to be of a pronounced silty character, but the presence of shale fragments appreciably lightens the texture and ensures satisfactory drainage.

The Neath Light Loam is derived from Pennant Grits. Typically it is a dull brown light loam over a yellowish brown subsoil. Occurring generally in high ground, these soils are usually of indifferent fertility and tend to deficiency in lime.

The Ilston Medium Loams are derived from non-calcareous Carboniferous drift and are generally fertile soils carrying good grassland. A lighter type of the Ilston is the Ilston Sandy Light Loam. Patches of sandy and gravelly soil also occur. Their occurrence is too sporadic to admit of mapping except on a very detailed scale.

With impeded drainage in this suite, we have the Pengwern Medium Loam. These soils are generally uncultivated commons with a vegetation of sedges and rushes. There is often a tendency to peat formation. It is difficult to understand how these soils have escaped improvement, for drainage would not appear to offer insuperable obstacles.

The Stouthall Light Loam, a drift soil of mixed Monmouth and Gower material, is a good soil for general farming, and is sometimes, in its lighter phases, used for market gardening.

The Oldwalls Light Loam formed from Gower and Monmouth material is a deep free working soil of fair agricultural value.

The Murton soil is derived from mixed Neath and Gower material and is a free working soil largely used for market gardening.

Marine alluvium occurs along the north coast of Gower. It is generally impervious and waterlogged. Except for the better drained patches it is of little importance. In some places the texture has been improved by admixture of sand from the adjoining dunes.

Monmouthshire.

The area surveyed in this country lies between Cardiff and Newport. It embraces the extensive Wentlloog Flat together with some of the elevated country which overlooks it. A portion of the alluvium of the River Rhymney is also included.

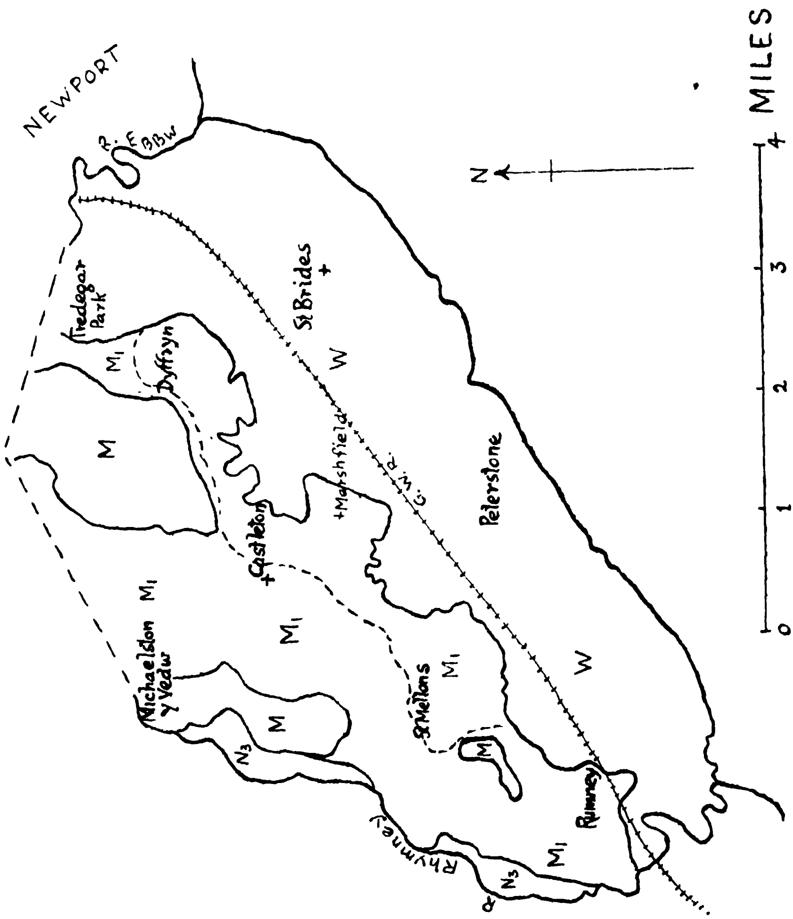

FIG. 2. WENTLLOOG DISTRICT, MON.

The soils of the elevated country as a whole belong to the Monmouth Suite, the country rock being Old Red Sandstone with occasional small outcrops of Old Red Marl. As regards the alluvial soils, it is not easy, particularly from a field examination, to assign their geological origin. In the case of the marine alluvium it is probable that the predominant material is of Old Red Sandstone character. The Rhymney deposit is undoubtedly very mixed debris with Carboniferous material as the main contribution; a certain admixture of Monmouth residue is also to be expected.

The topography of the area shows marked variation. On the higher ground, where the drift is comparatively shallow, and sometimes absent, the outline is that of smooth, broad ridges. On these upper reaches the surface outline is largely determined by the solid rock. At lower levels, where the drift mantle is deeper, the ground is generally sharply undulating or hummocky. The Wentlloog marine flat provides a marked contrast. It forms a monotonous, low-lying plain broken only by artificial watercourses.

The following types have been recognised in this area :—

	Series.	*Type.*
Monmouth suite	Monmouth (M)	Light Loam. Silty Loam.
	Castleton (M_1)	Gravelly Light Loam.
	Wentlloog (W)	Clay Silt.

In addition there is a series of drift soils, the Marshfield Sandy Loam, which resembles the Castleton but includes an admixture of Carboniferous material, and an alluvial series, the Rhymney Light Loam of non-calcareous Carboniferous material with some Old Red admixture.

The Monmouth Light Loam occurs on the higher ground. The profile is of variable depth but the rock is usually at about two feet. The surface soil is a bright reddish brown light loam, containing, as the analytical figures show, a high proportion of fine sand. The subsoil is of a brighter red colour and of an open texture, containing fragments of disintegrating rock. The drainage is free and there is a liability to seasonal drought. Such analyses as have been made indicate a deficiency of available phosphate. Lime is also generally deficient.

The Monmouth Silty Loam is derived from the Old Red Marls and has a very limited extent. The profile is deep and the only obvious difference in passing from soil to subsoil is the compacter character of the latter. The colour is bright red throughout the profile.

Most of the soil of the upper ground belongs to the Castleton Series which is, in this area, a gravelly light loam. Typically it is a bright reddish brown or brownish red soil containing 60 to

70 per cent. of the sand fractions. The proportion of stones is variable but is sometimes dominant. Both the Monmouth and the Castleton soils are distinguished by their low content of organic matter. Yet this condition does not appear to be incompatable with high fertility. Although, in some cases, the Castleton soils contain abundance of lime, the general tendency is towards a deficiency of this constituent. Many almost derelict grassland soils in the localities of Michaelston-y-Vedw and Penylan appear to suffer from this defect. Phosphate is naturally deficient but has often been increased by manuring.

A variant of the Castleton is the Marshfield, in this area a Sandy Loam. The material is mainly Old Red débris, but the yellowish brown colour indicates an admixture of other material, probably of Carboniferous origin. These soils are of good depth, open texture, and fairly free of stones. They are used to a considerable extent for market gardening.

About 12 square miles of this area is formed of a deposit of estuarine mud. These soils have been termed the Wentlloog Clay Silt. The area covered by them is a monotonous, almost treeless expanse of grassland. The saltings fringing the flat on the sea side appear to be raised above the inland level. This, and the impervious character of the soil renders drainage a difficult problem. The profile consists of about eight inches of stiff clay loam, in which the clay and silt form about 70 to 80 per cent. of the total, overlying an impermeable bluish grey to yellowish grey clay subsoil. The status of these soils with regard to plant food does not appear to be generally unfavourable, but the main need is for physical improvement by drainage. Such value as the land at present possesses is entirely due to the extensive system of drainage ditches.

There is a set of soils of mixed origin which we have termed the Rhymney Light Loam. The material is mainly glacial drift originating from non-calcareous Carboniferous rocks, but there is also an admixture of Old Red material. Typically, it is a yellowish brown light loam over a yellowish subsoil of similar texture. It is of fair fertility and a considerable proportion is under arable rotation. Lime is fairly satisfactory but phosphate may be low.

Llangunnor Parish, Carmarthen.

This is a rural parish of 5,884 acres, lying immediately southeast of the town of Carmarthen. The rocks underlying the area include representatives of the Cambrian, Ordovician, and Old Red Sandstone systems, but the solid geology is very commonly concealed by a mantle of glacial drift. The drift is made up of the débris of non-calcareous Lower Palaeozoic sediments and consequently the soils to which it gives rise belong to the Powys suite. Old Red Sandstone underlies the southern part of the parish, but its outcrop is concealed by drift and its influence on the character of the soil is subordinate.

Grits in the lower part of the Ordovician produce the prominant features of the topography. They give rise to a pronounced

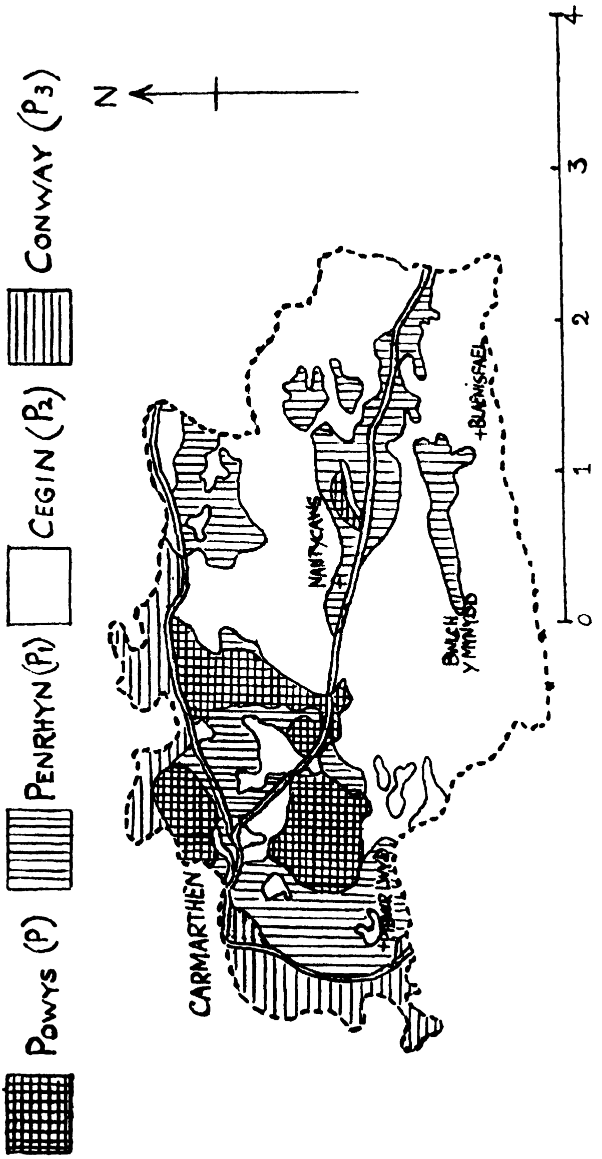

FIG. 3. LLANGUNNOR PARISH, CARMARTHENSHIRE.

winding ridge running in a roughly N.E.-S.W. direction. Where this ridge abuts against the Towy alluvium it terminates in a steep wooded slope. More commonly, however, the slopes of this feature are plastered with boulder clay, and the occasional valleys and hollows which cut into it are also filled in with drift. The greater part of the remainder of the parish, including the whole of the land lying to the south-east of the Afon River, is smoothly featured drift covered country. The River Towy forms the north and west boundaries of the parish and some of its alluvium comes within the area to be described. A smaller extent of alluvium occupies the bottom of the valley of the Afon Pibwr.

Grassland farming is by far the principal occupation in Llangunnor Parish. In fact, of the 5,884 acres, not more than 120 were under arable cultivation of any kind during the 1929 season. Milk production here, as in other areas, is found to be the most profitable system of farming. An additional reason for the reduction in the amount of ploughed land in the parish is the fact that cereal crops have a tendency to " lodge ".

An outstanding feature of the parish is the surprisingly high proportion of wet land. The deficiently drained drift soils comprise the Cegin series. The prominence of this series on the soil map shows how widespread the trouble is. Generally speaking, conditions are quite favourable for the improvement of this land by thorough-going drainage operations. Mole drainage would probably prove very effective.

All the soils of the parish belong to the Powys Suite. The following types were distinguished :—

Series.	*Type.*
Powys (P)	Light Loam.
	Medium Loam.
Penrhyn (P_1)	Sandy Light Loam.
	Medium Loam.
	Heavy Loam.
Cegin (P_2)	Medium Loam.
	Heavy Loam.
Conway (P_3)	Clay Silt.
	Silt Loam.

The Powys Light Loam occupies the crest of the ridge produced by gritty beds in the Ordovician system. The parent material consists of grit, interbanded with shale. The soil is an open-textured brown light loam. Soil depth is variable, but tends to be shallow. The subsoil is light in texture and rather reddish-brown in colour. Drainage is very free and often excessive. Above Wenallt, where the rock is very near the surface, the soil is liable to drought in an average summer. Both the lime status and the phosphate status of the Powys Light Loam in this area are unsatisfactory. The Powys Medium Loam in formed on the Ordovician shales and it is consequently somewhat heavier in texture than the soil on the grits. Owing to the more easily weathered nature of shale the profile is also generally deeper. There are most commonly about 12 inches of slightly greyish-brown medium loam over a rather brighter brown subsoil of the same texture. There is always a more or less evident content of shale particles. The principal area occupied by this soil lies on the detached hill on which stands Llangunnor Church. A sample from this area shows a satisfactory lime status but a low phosphate content.

Sandy glacial drift near Ty-gwyn produces a few acres of light sandy soil, the Penrhyn Sandy Light Loam. A few small patches of similar material occur along the valley of the Afon Pibwr. The total area occupied by this type is too small to permit of any generalisations regarding its natural content of plant food. The Penrhyn Medium Loam is a moderately stony greyish-brown medium loam of satisfactory working depth. The subsoil is distinctly heavier, being most commonly a yellowish-brown clay loam. Fertility is moderately good. The samples of this type which have been analysed show a satisfactory content of available lime. This fact is no doubt the result of treatment. The main area occupied by the Penrhyn Heavy Loam lies around Penddaulwyn. It is a brown or greyish-brown heavy loam passing at about nine inches into a yellowish-brown stiff subsoil.

The Cegin Medium Loam is of minor importance in this area. The profile consists of about six inches of brownish grey medium loam over a yellowish-grey slightly sandy clay. The soil suffers from imperfect drainage and the aeration is consequently poor. This condition has resulted in colour mottling, particularly in the subsoil. Of all the soils mapped in Llangunnor Parish the Cegin Heavy Loam occupies the greatest area. It is a greyish-brown or brownish-grey heavy loam underlain by stiff yellowish-brown clay. Owing to the heavy nature of the profile, drainage is impeded. This fact is evidenced by the widespread occurrence of rushes. In many parts conditions are so bad that some accumulation of peat has taken place. Most of the land has a definite slope and there is no doubt that, in general, drainage would greatly enhance the fertility of the soil. As regards plant food, the conditions seem to be satisfactory.

The Conway Clay Silt occurs on the alluvium of the Afon Pibwr. Coarse material is exceedingly low, the dominant fractions being silt and clay, which are present in almost equal proportions. The stiff nature of the profile and the absence of slope combine to render the drainage deficient. Rushes are a characteristic feature and sometimes form a dense growth. The situation of the alluvium hinders regional improvement by drainage, and any treatment of this character would be of necessity only local in effect.

The Conway Silt Loam is another alluvial soil but the alluvium on which it lies is that of the River Towy. It forms a strip along the northern and western boundaries of the parish. It is distinctly lighter in texture than the Pibwr alluvium, and carries good pasture.

Bangor District.

This area, extending to about 20 square miles, lies on the

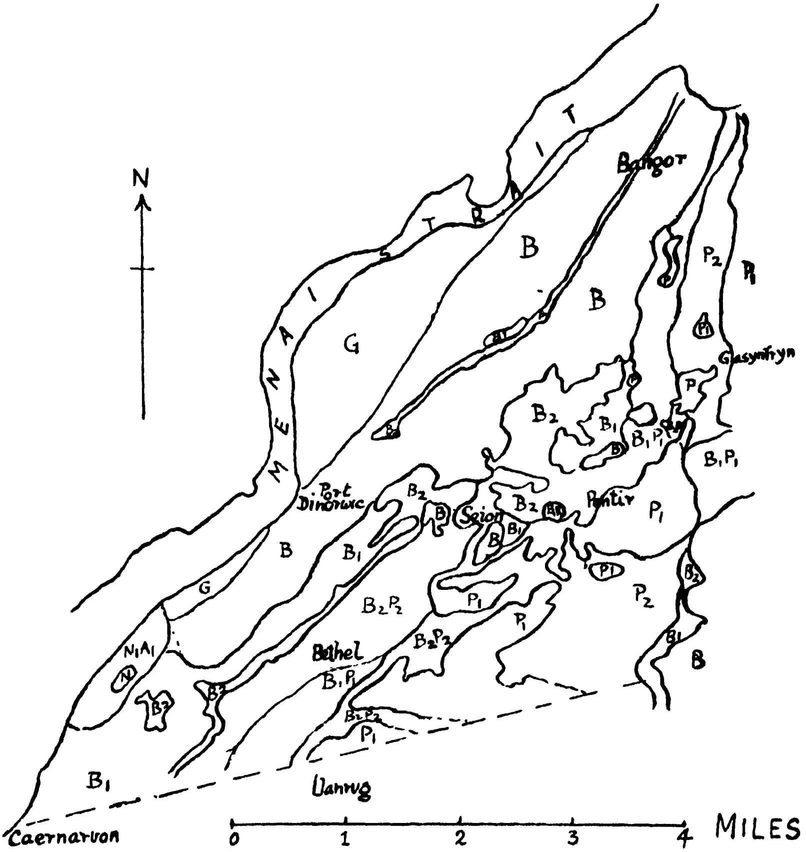

FIG. 4. BANGOR DISTRICT.

south-east side of the Menai Straits. Its general physical features are dominated by the ridge of volcanic rocks running south-west from Bangor parallel to the Straits and by the foothills of the mountains which lie further inland. Between the Bangor ridge and the mountain land lies an upland valley system, drained by the Cegin and its tributaries to the north-east and by the Seiont and its tributaries to the south-west. The surface is much complicated by glacial drift deposits which often occur as hummocky ridges of sands and gravels. The valley region is characterised by the occurrence of extensive areas of undrained wet bottoms and alluvial flats. The lowland on the Menai side of the Bangor ridge is generally well drained and free from wet areas.

The mapping and classification of the soils of this area are extremely difficult owing to the complications of the solid geology and also to the complications of the drifts of which most of the soils are composed. Broadly speaking the rocks of this area belong to two divisions, namely, the Ordovician and Cambrian mudstones, shales and slates, and the volcanic rocks of the Bangor ridge which include quartz porphyries, quartz felsites and acid volcanic ashes. With the volcanic rocks we may include, from the point of view of soil formation, the Cambrian Grits, which are hard and crystalline in texture.

The following types of soil have been encountered :—

Suite.	*Series.*	*Type.*
Bangor	Bangor (B)	Stony Light Loam.
	Ebenezer (B_1)	Stony Light Loam.
	Sion (B_2)	Medium Loam.
Powys	Powys (P)	Medium Loam.
	Penrhyn (P_1)	Medium Loam. Gravelly Light Loam.
	Cegin (P_2)	Heavy Loam.
Gower	Gower (G)	
	Pentraeth (G_1)	
Neath	Parciau (N)	Medium Loam.

In addition, there are mixed series in which the parent material is mixed drift, the most important being the mixture of Bangor and Powys drifts (B_1P_1). A small area of mixed Carboniferous Red Measure and Mona Complex drift (N_1A_1) is also encountered.

The Bangor Stony Light Loam is of wide occurrence and occupies most of the elevated country between Bangor and Caernarvon. The parent rock is generally resistant to weathering and the soil profile tends to be shallow and stony. Rock outcrops are numerous and are characteristic of the area occupied by this series. The profile is, typically, a reddish brown light loam over a more brightly coloured subsoil of similar character. Stones are numerous throughout. As regards plant food, the most common deficiency is lime, a condition which might be expected when the nature of the parent rock is considered. Phosphate status depends largely on management and manuring. The corresponding drift soil, the Ebenezer Light Loam, occurs usually on lower ground. The profile is deeper, but in other respects these soils are similar to the Bangor series. Lime tends to be deficient. The value of this soil depends largely on the treatment it receives. Under conditions of restricted drainage, we have the Sion Medium Loam. The soil is generally of a brownish grey colour and the subsoil a gritty grey or yellowish grey clay with brown or ochreous mottlings. We may distinguish two sub-divisions of the Sion, namely the Sion A soils, which have been to some extent improved, and the Sion B soils, which are in a condition of permanent wetness.

Powys soils do not occur to any great extent owing to the country being mainly drift covered. They are confined to isolated features and vary somewhat in texture according to the lithology of the parent rock. The usual texture is a medium loam. The Penrhyn series, derived from drift material, is more widespread and there are two types, namely, the Penrhyn Medium Loam derived from boulder clay, and the Penrhyn Gravelly Light Loam derived from glacial sands and gravels. The former is a brown or greyish brown medium loam over a yellowish brown heavy loam or clay. The texture is ameliorated by the presence of shaly fragments. These soils are of good depth and may be regarded as the most fertile in the district. The Penrhyn Gravelly Light Loam generally occurs on hummocks, as in the neighbourhood of Pentir. The profile is open in texture and the drainage very free. Pastures quickly deteriorate on this type of soil, which tends to be deficient in lime.

Soils of the Cegin series are developed with impeded drainage. Typically they occur on the slopes of valleys. The profile shows a greyish brown or yellowish grey heavy loam over a yellowish grey stiff subsoil with mottlings. Some of this type of soil has been successfully improved by drainage and it seems likely that the area thus treated might be profitably increased. Mole drainage might be attempted.

The Gower and Pentraeth series are represented by an area on the side of the Straits which is mainly park land and has not been surveyed. The Neath suite is represented by a sedentary soil derived from the Carboniferous Red Measures. This is a bright reddish brown medium loam which we have termed the Parciau series. It is of fair to high fertility.

As will be seen from the map there are considerable areas of soil of a mixed character.

Llandinam District, Montgomeryshire.

A reconnaissance of the soil of this parish has shown that the soils belong entirely to the Powys suite, each series being represented. With the exception of the gravelly phases of the Conway series, the soils are generally rather heavy. The Powys soils, often fertile at elevations of over 800 feet, are deep medium to heavy loams with a high content of shale fragments. Lime is inclined to be deficient. The Penrhyn series is largely made of downwash material. The Cegin soils are sporadic in occurrence and are usually of fair grazing value. The alluvial Conway series is represented by two types, namely the heavy loam and the light gravelly loam, the latter being very inferior agriculturally and often possessed by gorse.

Generally speaking, the soils of this area are of more than average fertility, the Penrhyn and the heavier Conway soils being particularly good land. A striking feature of this district is that in spite of the heavy texture of the soils, there is a high proportion under arable cultivation.

BACTERIOLOGICAL EXAMINATION OF MILK FOR LOCAL AUTHORITIES IN WALES.

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A considerable portion of the routine laboratory work carried out by the Advisory Dairy Bacteriological Services at Bangor and Aberystwyth during the past five years has been in connection with County Clean Milk and Butter Competitions. This type of work was inaugurated during the first three months of 1925 with a competition organised in the Brecon and Radnor (Joint) area (1, 2). Up to the time of writing thirty competitions have been organised in Welsh counties.

TABLE I.

Milk and butter competitions. Wales 1925-29.

County.	*1925*		*1926*		*1927*					
	Competitors.	*Milk samples.*	*Competitors.*	*Milk samples.*	*Competitors.*	*Milk samples.*	*Competitors.*	*Milk samples.*	*Competitors.*	*Milk samples.*
Anglesey ...	—	—	—	—	9	81	10	96	15*	81
Brecon and Radnor ...	11	66	10	90	—	—	8	91	14*	56
Caernarvonshire ...	—	—	—	—	—	—	—	—	19	114
Cardiganshire ...	—	—	—	—	24	192	28	162	14†	56
Carmarthenshire ...	—	—	13	91	9	72	11	99	—	—
Denbighshire ...	—	—	17	129	—	—	61	788	—	—
Flintshire ...	—	—	9	54	10	80	16	128	13	117
Glamorganshire ...	—	—	—	—	—	—	—	—	—	—
Merionethshire ...	—	—	—	—	—	—	14	56	—	—
Monmouth ...	—	—	—	—	—	—	—	—	—	—
Montgomeryshire ...	—	—	10	80	13	98	—	—	—	—
Pembrokeshire ...	—	—	8	48	13	104 *	23*	147	31*	189
Total ...	11	66	67	492	78	627	171	1567	106	613

Total number of competitions—30; Total number of competitors—433; Total number of samples—3,365.

* Including butter competitions. † Goats' milk competitions.

Table I.

Much useful work has been undertaken through the medium of these competitions, and the data accumulated through the systematic testing of the milk samples have shown that a good proportion of Welsh dairy farms are capable of producing a milk supply that attains Grade A standards (3, 4).

The hygienic quality of our milk supply is undoubtedly showing considerable improvement, and it is now possible in some instances to obtain a better price for better quality (5).

" This has given rise at the present time to more than twenty schemes involving the principle of giving preference to the best producers and eliminating unsatisfactory supplies. These schemes vary somewhat in detail, but fall roughly into three main groups :—

(1) Bonus payments on a gallonage basis in connection with County Clean Milk Competitions.
(2) Schemes which provide for money prizes to suppliers who enter County Clean Milk Competitions.
(3) Bonus payments on gallonage by distributors conducting their own testing and advisory service ".

It was evident that the usefulness of the work carried on in connection with Clean Milk Competitions could be extended considerably along other lines. Localised competitions, some of which were connected with butter (6) and cheese (7) problems were organised in different areas in England and Wales during 1927 and 1928.

In the main, however, the work has been considerably extended in Wales through the active co-operation of local sanitary authorities. Towards the end of 1925 the Bingley Urban District Council (Yorkshire) organised a Clean Milk Campaign (8). This campaign was carried on by visits to farms and educational work amongst producers, bacteriological examination of milk samples, and educational work among the consumers. Campaigns of a similar nature were initiated by the Aberystwyth and Wrexham Borough Councils early in the following year (9).

The reports received from Public Authorities " on the present conditions of the milk supply " during the National Milk Conference of 1926 (10) show that only twenty Urban Districts and five County Authorities in England and Wales were then carrying on systematic bacteriological examinations of milk samples for bacterial count and coliform organisms content. In addition twenty-six authorities reported that they carried on examinations for tubercle organisms. Of the total number of 5,114 examinations for tubercle 343 or 6.7 per cent. were positive. The value of advisory bacteriological work carried out in conjunction with local sanitary authorities has now become well recognised. The Chief Medical Officer of the Ministry of Health in his annual report for 1926 (11) states :—

> " The practice of graded milk production, with its appeal to bacteriological standards, has of recent years developed dairy technique into an art with which sanitary inspectors whose duties include the sanitary supervision of dairies, can no longer afford to be unfamiliar. A practical knowledge of this work is necessary for maintaining a proper balance of judgment as to what will satisfy the essentials as regards structure, equipment, and methods which the Milk and Dairies Order empowers him to enforce. Many sanitary inspectors have made themselves familiar with these questions in recent years, and their knowledge has been reflected in the improvements which they have been able to bring about in the milk produced in their districts. Many more are engaged in acquiring knowledge and experience of these matters by attendance at classes and demonstrations which have been organised at various centres. The Ministry considered that attendance at such courses would make for more efficient work under the Milk and Dairies Order and would tend to promote uniformity of action under it throughout the country, and have intimated that in the case of any sanitary authority desiring their Sanitary Inspector to attend this or other special course of instruction of the kind, payment of his reasonable expenses can legally be incurred without any sanction by the Department ".

Courses in clean milk production for Sanitary Inspectors.

Short courses have been held throughout England and Wales during the past years. Most of these courses have been held at provincial centres (agricultural colleges and university departments of agriculture) for periods of four to seven days. Decentralized courses consisting of afternoon or evening sessions held

Sanitary Inspectors' courses—England and Wales.

Year.	*Courses held.*	*Number of inspectors attending.*
1925-26.	9	147
1926-27.	15	327
1927-28.	24	426
Totals ...	48	900

one day per week over a period of four to five weeks have been also held in particular counties.

Sanitary inspectors from 765 local authorities out of a total of approximately 1,800, have attended up to the present.

Seven of these courses have been organised in Wales, two at Aberystwyth, three at Bangor, and a decentralized one at the Dairy School, Demonstration Farm, Pencoed, Glamorgan, together with one at Cardiff.

Sanitary Inspectors' courses—Wales.

Date of course.	*Centre.*	*No. attending.*
Jan., 1926.	University College, Bangor ...	13
Mar., 1926.	University College, Aberystwyth ...	22
Mar., 1927.	University College, Bangor ...	11
Oct. and Nov., 1927.	Glamorgan Demonstration Farm, Pencoed	23
1928.	Welsh Board of Health, Cardiff ...	50
Jan., 1929.	University College, Bangor ...	22
June, 1929.	University College, Aberystwyth ...	28
	Total	169

Clean milk conferences.

Three of these Welsh courses have been followed by Clean Milk Conferences at which local milk producers and vendors, clean milk competitors, Farmers' Union and Milk Vendors' Association officials, Medical Officers of Health, Sanitary Officials, Veterinary Surgeons, County Agricultural Organisers, Dairy Instructors, and members of Urban and Rural District Councils attended. Papers dealing with practical aspects of graded milk production, bovine diseases affecting the milk supply, bacteriological aspects of market milk, and economics of clean milk production were read and discussed with keen interest. The courses and conferences have undoubtedly improved the facilities for co-operation between dairy-men, public health officials, and bacteriologists. In addition they have been the starting point of the majority of clean milk campaigns which have been organised in the various urban and rural districts in the Principality.

Examination of milk.

Over 8,000 samples have been bacteriologically examined at Aberystwyth and Bangor from approximately 800 farms during the course of these campaigns, as compared with 3,365 samples from about 300 farms taken during the course of clean milk and butter competitions.

Milk samples examined for Urban and Rural Councils.

District.	*Date of commencement of scheme.*	*No. of samples examined.*
ANGLESEY.		
Holyhead Urban District ...	23/11/27	18
BRECONSHIRE.		
Builth Wells Urban District ...	13/ 1/26	18
Builth Wells Rural District ...	18/ 1/26	10
Hay Rural Sanitary Authority ...	15/ 6/27	8
Crickhowell Rural District ...	30/ 1/26	2
Brecknock Rural District ...	2/12/29	—
CAERNARVONSHIRE.		
Bangor Borough ...	3/10/27	98
Criccieth Urban District ...	28/11/27	11
Ogwen Rural District ...	21/ 3/27	46
Llanfairfechan Urban District ...	14/ 9/27	23
CARDIGANSHIRE.		
Aberystwyth Borough ...	29/ 6/26	1,279
Aberystwyth Rural District ...	3/ 5/27	148
Aberayron Urban District ...	22/ 3/27	98
Aberayron Rural District ...	8/ 8/27	85
New Quay Urban District ...	10/ 3/27	42
Lampeter Rural District ...	13/ 9/27	26
Tregaron Rural District ...	1/11/27	40
Llandyssul Rural District ...	22/ 5/28	15
Cardigan Rural District ...	25/ 4/28	14
CARMARTHENSHIRE.		
Llandilo Fawr Rural District . .	22/ 5/28	13
Ammanford Urban District ..	13/11/28	2
Burry Port Urban District ...	1/11/28	12
DENBIGHSHIRE.		
Wrexham Borough ..	26/10/26	866
Wrexham Rural District ...	13/11/28	54
Denbigh Borough ...	18/ 2/28	30
Ruthin Borough ...	26/ 7/27	30
Ruthin Rural District ...	20/ 9/27	10
Llanrhaiadr Rural District ...	21/ 2/26	6
Chirk Rural District ...	19/ 4/28	81
FLINTSHIRE.		
Rhyl Urban District ...	4/10/27	90
Rhydymwyn Rural District ...	30/ 8/28	20
Prestatyn Urban District ...	10/ 9/28	15
GLAMORGANSHIRE.		
Ogmore and Garw Urban District ...	20/ 9/29	—
MERIONETHSHIRE.		
Dolgelley Rural District ...	13/ 3/29	11
MONTGOMERYSHIRE.		
Welshpool Borough ...	5/11/26	85
Llanidloes Borough ...	6/12/26	21
Llanfyllin Borough ...	29/11/26	28
Llanfyllin Rural District ...	22/ 4/28	194
Newtown and Llanllwchaiarn ...	5/11/26	28
Machynlleth Urban District ...	19/11/26	17
PEMBROKESHIRE.		
Milford Haven Urban District ...	15/ 9/28	18
RADNORSHIRE.		
Knighton Urban District ...	27/ 8/28	40
Presteign Urban District ...	11/ 9/28	9

It can be seen from the above table that the practise of taking samples of milk for bacteriological analysis in Welsh urban and rural districts has extended now over quite a considerable period, and viewing the situation generally one is justified in stating that distinct improvements have taken place in the production and distribution of milk in these areas. The average standard attained by seasonal batches of samples taken in the various districts varies a great deal, 85 per cent. of the samples from one urban district were within Grade A bacteriological standards, whereas only 5 per cent. were within this standard for another rural district. Considerable progress has been made since the commencement of the work.

Some of the sanitary authorities have had clean milk campaigns in operation for over four years, and in some cases ten or more samples have been examined from each producer or retailer.

The results of these analyses show exceptional improvement in the majority of cases.

Producer A.69. Aberystwyth borough.

	1926. May 19.	*1926. Aug. 4.*	*1927. May 18.*	*1927. Sept. 2.*	*1928. Feb. 15.*
Bacterial count per c.c.	220,000	2,240,000	95,000	18,600	950
Coliform organisms	+ 1/100 c.c.	+ 1/1000 c.c.	+ 1/1000 c.c.	+ 1/100 c.c.	Absent.
Keeping quality —days	1½	1½	2½	2	4

	1928. Mar. 7.	*1928. Mar. 27.*	*1928. April 19.*	*1928. May 23.*	*1928. May 3.*
Bacterial count per c.c.	16,500	2,090	1,470	800	18,000
Coliform organisms	Absent.	Absent.	Absent.	Absent.	Absent.
Keeping quality —days	4	3¾	4¼	3¾	3¾

There are, however, some problems which one hopes will be improved as this work increases, and more experience is gained by those concerned. In many urban districts the bulk of the milk supply is produced outside the urban area, and in consequence the responsible sanitary official of the urban district having very little power outside his own area, is unable to supervise the methods of the production of milk which is retailed in his own area. In one urban district in North Wales there are thirty-four retailers of milk, but of this number only eleven are actual producers within the area. In another Mid-Wales borough with seventy-six vendors, only eleven producers are situated within the borough, and over whom the medical officer and sanitary inspector have any jurisdiction with regard to the actual production of the milk. A certain amount of co-operation is being carried out between the urban and rural sanitary authorities, but one must consider how widely scattered are most of the rural areas, and how multitudinous are the duties of rural sanitary inspectors, many of whom hold the dual appointment of sanitary inspector and surveyor. There is one town in North Wales where this difficulty has been overcome to a certain extent, and that is by educating the producer through the retailer. In this particular district several hundred samples have been taken for bacteriological analyses from the retailers with very satisfactory results. A copy of the report on the sample is sent by the sanitary inspector of the district to the retailer. The retailer informs his producers of the state of affairs, with the result that the producer almost invariably visits the public health office with a view to gaining information regarding the possible sources of contamination and the means of eliminating these sources. After advisory visits samples are again taken after a lapse of a week of two, and these are usually found to be greatly improved.

One cannot emphasise too strongly the urgent necessity for advisory and educational work among producers and retailers. It is not sufficient merely to take samples and send reports. To the majority of producers and retailers a report in itself is of little value, whereas, if followed up by an actual visit to the farm or retailer's premises with advice as to methods of improvement in production and handling, the results would be infinitely more beneficial. Under the present system this is not possible in all districts owing to the various difficulties which arise—the chief among them being the lack of time on the part of the rural sanitary inspectors, dairy instructors, and advisory bacteriologists. To meet this difficulty it would be to the mutual advantage of both producers and local authorities if county sanitary inspectors were appointed who could co-operate with the advisory dairy bacteriological departments and the dairy instructors in educating and advising the farmer and retailer.

Sampling and bacteriological examinations.

Samples are generally taken in batches of four to a few dozen, dispatched to the laboratory as soon as possible and examined at approximately the same age. In the case of morning's milk examinations are carried out at twenty-seven to twenty-eight hours, and in the case of evening milk at twenty-four hours from the time of milking. All samples awaiting examination are kept at a constant temperature of 60°F.

The means of delivery varies with the district in which they are taken. In the immediate locality of the laboratories it is possible for samples to be delivered almost immediately after they have been taken. In other cases they are delivered by post, rail, or road, and the temperature during transit, particularly during summer months, is a factor which has a decided influence on the result of the examination (12). In a few cases samples are sent in specially constructed ice-boxes, which is, of course, the ideal method of delivery, and efforts should be made by all local authorities to adopt this method where possible—at all events where samples have to travel a considerable distance and spend several hours en route.

The milk samples are examined as follows :—

(*a*) Total bacterial count on standard beef extract agar, incubated forty-eight hours at 37°C.

(*b*) Coliform organisms content by means of litmus bilesalt lactose medium incubated seventy-two hours at 37°C.

(*c*) Keeping quality, calculated in days or hours, at 60° (low temperature incubator).

These three tests are carried out in strict accordance with the official routine methods for the bacteriological examination of milk (13).

(*d*) Butter fat tests by means of the Gerber method are frequently carried out.

(*e*) Some batches of samples are also examined by means of the methylene blue reductase test and the fermentation test (twenty-four hours at 37°C.). In addition a detailed microscopical examination is being carried out with certain supplies, in connection with investigational work on the microscopical examination of market milk.

(*f*) Examination of samples for Mycobacterium tuberculosis —the ordinary microscopic examination for tubercle organisms—has been carried out at the two laboratories for some time. The concentration method as described by Douglas and Meanwell (14) is now being used, but arrangements are now being made at Aberystwyth to confirm the microscopical examination by means of animal inoculation. It is hoped to commence with this work during January, 1930, and particulars will be circulated to all local authorities in the college advisory area in due course.

Reporting results.

The results of the bacteriological examinations are sent to the producers or retailers concerned, the sanitary inspector, and often to the dairy instructor for the county. Stress is laid on the fact that results can be used for educational and advisory purposes only, and not for official action or purposes of litigation. It has been found that a simplified report form giving marks arranged on a simple percentage basis in addition to the actual bacteriological results is very useful in explaining the importance and meaning of bacterial counts.

REPORT ON MILK SAMPLE.

Name of Sender .... Code No. ....
Address .... District....................
....

Test item.	*Perfect score.*	*Score allowed.*	*Remarks.*
Bacterial count	30	4	Bacteria found per cubic centimetre :—180,000.
Coliform organisms ...	20	5	Coliform organisms present in 1/100th of a cubic centimetre.
Keeping quality	30	8	Days sweet at 60°F. :—2½.
Fat ...	5	5	Per cent. found 3.90.
Visible dirt ...	5	3	Few specks of visible dirt on testing pad.
Delivery ...	10	6	Fair.
Total ...	100	31 %	Sample Fair.

GENERAL REMARKS.—Bacterial count not exceptionally high, but coliform (manure and dirt) organisms are present in large numbers. Consequently keeping quality is low.

Date received—June 9th, 1927. Date reported on—June 12th, 1927.
Temperature 76°F. Signed ....
(Sanitary Inspector).
Age on examination, 28 hours. ....
(Bacteriologist).

The marks for bacterial count, coliform organisms, keeping quality, and butter fat are calculated as one-tenth of the marks given in the various tables contained in " The Guide to Clean Milk Competitions " (Second Edition), 1926. (18).

This type of report is generally signed by the Sanitary Inspector or Medical Officer of Health in addition to the Bacteriologist carrying out the analyses, the former filling up the marks given for the method of delivery.

Several people concerned with this type of work are of the opinion that simplified bacterial standards can be very useful, and enable the local authorities to have a definite classification into which ungraded market milk can be placed. The following standards have therefore being used by the authors in reporting on the bacteriological examination of market milk :—

Standards used in reporting on the bacteriological examination of market milk.

Standard.	*Bacterial count.*	*Coliform organisms.*
Excellent	Under 30,000 per c.c.	Present in 1 c.c.
Good	30,000—200,000.	Present in 1/10 c.c.
Fair	200,000—1,000,000.	Present in 1/100 c.c.
Bad	500,000 or over.	Present in 1/1000 c.c.

It will be seen that the " excellent " standard is equivalent to the " certified " bacteriological standards and the second standard to counts allowed in Grade A milk. It may be the opinion of some that the standard suggested here for a " good " market supply is somewhat difficult to attain, but having regard to the results obtained so far and the provisions of the Milk and Dairies Order 1926, it should be possible for all market milk to attain this standard if produced according to the regulations. It would probably be of great value to both producer and retailer if some such standard were universally adopted in the reporting of samples, as the information that a sample of milk is either " excellent ", " good ", " fair ", or " bad ", will often convey more meaning, when combined with the bacteriological results, than the mere figures of the report by themselves.

Educational work amongst producers and retailers.

The bacteriological examination of the milk is generally followed up by visits to the producing farms and the retailers' premises. The sanitary inspectors, medical officers, dairy instructors, and advisory dairy bacteriologists co-operate in this work, and in addition to explaining the results of the bacteriological examinations give advice with regard to possible means of improvement in methods of production and distribution. A considerable number of lectures and demonstrations on better milk production and distribution have been given throughout the various areas during the course of the past seven years.

Water supply on the farms.

A very vital problem which affects the producers and particularly those on outlying farms is the question of the quantity and quality of the water supply. Visits to farms show that there have been distinct improvements of late in the methods of production, particularly in the cleaning of the cowsheds and the cows. Further improvements such as efficient washing and sterilizing, or even scalding of the utensils, and cooling of the milk are undeniably handicapped by the lack of an adequate and clean water supply. In most cases water is obtained either from a shallow well or a stream, and in such a spell of drought as has been experienced this year the problem is a very serious one, and is a big factor influencing the improvement of the milk supply in many rural districts. The bacteriological quality of the water supply of dairy farms is undoubtedly another important factor in the production of milk of good keeping quality. The numerous outbreaks of " ropy " taints in the milk supply of Mid Wales led one of the authors to make a systematic bacteriological investigation of some of the water supplies of this district. The data so far accumulated is not sufficient to warrant any definite conclusions, but it is significant to notice that of 141 samples examined this year 53 per cent. were condemned on bacteriological grounds. The samples were taken from three types of sources, dairy farm supplies, rural wells and pumps, and urban district supplies. The samples condemned as unfit for use were distributed as follows :—

Dairy Farm supplies	59 per cent.
Rural District Supplies	53 per cent.
Urban District supplies	14 per cent.

Educational work among consumers.

A large number of lectures on the food value of milk and other dairy products, the importance and value of Graded and Tuberculin Tested Milk, and the care of milk in the home, have been delivered at various centres throughout the districts organising Clean Milk Campaigns. To maintain the interest created by the lectures, milk exhibits demonstrating food value and methods of hygienic production, distribution, and storage in the home have been shown at the larger towns by the authors.

Frequent popular articles in the local press also help to maintain an intelligent interest in market milk supply.

Bacteriological examination of water supplies.

Source.	*Samples condemned on bacteriological examination.*				*Samples passed as fit for dairy purposes.*		*Totals.*
	Excessive faecal pollution. Coliform organisms present in 1 c.c.		*Faecal pollution less. Coliform organisms present in 10 c.c.*		*Coliform organisms absent in 10 c.c.*		
	No.	*%*	*No.*	*%*	*No.*	*%*	
Dairy farm supplies ...	14	33	11	26	17	41	42
Rural supplies ...	25	27	24	26	43	47	92
Urban supplies ...	0	0	1	14	6	86	7
	39	28	36	25	66	47	141

Summary.

(1) Seven Short Courses for Sanitary Inspectors, dealing with The Hygienic Production of Milk, have been held in the Principality during the past four years.

(2) As a result of these courses as well as Milk Conferences held at Aberystwyth and Bangor, forty-three Borough, Urban and Rural Districts in Wales have organized Clean Milk Campaigns.

(3) In connection with the Campaigns nearly 3,500 samples of milk—from approximately 800 farms—have been examined bacteriologically.

(4) Regular bacteriological examination has shown that the Clean Milk Campaigns have resulted in a considerable hygienic improvement.

(5) Practically half the samples have attained Grade A Bacteriological Standards. In the case of some areas which have been carrying on the work for four years or more, 75 per cent. of the producers and retailers attain this standard even during summer months.

(6) Bacteriological examination of water samples from dairy farms and from Rural Areas has shown that a very large proportion are not fit for dairy purposes.

(7) The bacteriological analyses have been undertaken in connection with a scheme for advisory work among producers, retailers and consumers.

(8) The scheme is being extended to include examination for tubercle organisms in milk samples.

(9) Advisory bacteriological work along these lines is important inasmuch as all samples taken are surprise samples, while samples are taken at regular periods from all producers and retailers in the various districts.

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LABORATORY WORK IN CONNECTION WITH BUTTER COMPETITIONS.

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The keeping quality and general flavour of butter are the two most important characters from the standpoint of its market value. Butter which may be good in respect of texture, freedom from moisture, salt content and packing, may be seriously defective in flavour and score very low. Butter flavour is due to a large number of distinct factors, and the scoring judge is only able to appreciate the combination of these factors. Butter deterioration may be due to bacterial, chemical, and enzymatic action. The flavour of fresh butter, however, is in the main controlled by the flavours present in the cream during churning. The flavour of the ripened cream, unless pasteurization and the use of starters are employed, is due to a considerable extent to the care taken in the production of milk, the separating process, and the ripening of the cream. It is a well-known fact that butter of an exceptionally fine grade is being produced on many farms in Mid and West Wales. Unfortunately, however, although the best butter is of such a high standard, there is too much of the inferior article on the market, and buyers and consumers complain of the unevenness in flavour and keeping qualities. During recent years clean milk competitions and demonstrations have improved the hygienic quality of the milk produced in the area to a considerable extent. Very few butter producers have entered these competitions, as they thought they would be handicapped by lack of equipment.

Competition.	*Period.*	*No. of competitors.*	*No. of butter samples.*	*No. of milk samples.*
Pembrokeshire, 1928.	Dec. 1927–June, 1928.	12	60	12
Pembrokeshire, 1929.	February–June.	12	108	36
Brecon & Radnor, 1929.	March–December.	14	84	56

Butter competitions have therefore been organized in Pembrokeshire, Brecon and Radnor.

The methods of scoring in the 1929 competitions were as follows :—

	Maximum marks.
A. *Farm inspection.*	
(1) Care and cleanliness of cowshed and utensils	100
(2) Milk production and management (milking, separating, management of cream during ripening)	100
(3) Churning and butter-making	100
	300
B. *Laboratory examination.*	
Milk	100
Butter (100 marks for each sample)	600
	700

Total possible marks 1,000.

Each competitor is given a code number under which information and criticism is given, and only the names of the prize-winners are given.

Butter and milk samples are forwarded to the Agricultural Department of the College for examination and testing.

The examination of the milk samples consists of bacterial count, coliform organism content, keeping quality at 60°F, and butter fat content. Marks are awarded on the basis of the " Guide to Clean Milk Competitions ".

The butter samples which are unsalted are examined as follows :—

(*a*) Scoring on arrival, and examination at regular intervals for development of taints. Keeping quality at 60°F.

(*b*) Bacterial count on gelatine at 22°C.

(*c*) Bacterial count on standard agar at 37°C. and at 22°C.

(*d*) Mould and yeast count on acidified malt agar.

(*e*) " Bottle incubation " test.

(*f*) Hydrogen ion concentration on arrival and on discarding.

It is hoped to correlate the results of these tests when sufficient data have been obtained.

Judging and examination for development of taints.

The unsalted butter samples are tested immediately on arrival, *i.e.*, at twenty-four to thirty-six hours after churning, and marks given as follows :—

	Maximum.
Flavour and aroma	50
Texture	25
Freedom from moisture	15
Colour	10
Total	100

The butter is then placed in a low temperature incubator at a constant temperature of 60°F, and tested regularly for flavour and aroma. When a sample develops such a flavour or taint as to condemn it for consumption it is discarded, the keeping quality being calculated as the number of days which elapse from the time of churning to the time of discarding.

The score card used for awarding marks for keeping quality is as follows :—

Keeping quality. Days.	*Marks.*	*Keeping quality. Days.*	*Marks.*
21	50	12	23
20	47	11	20
19	44	10	17
18	41	9	14
17	38	8	11
16	35	7	8
15	32	6	6
14	29	5	4
13	26	4	2

The chief defects found in the samples were of two main types :—

(1) Flavour and aroma.

(2) Body and texture.

The most serious defects came under the first heading. A few samples had developed decidedly rancid or tallowy flavours on arrival; others had peculiar flavours due possibly to pasture weeds.

Taking one of the competitions as an example, the following resumé of results is obtained :—

Total number of butter samples = 60
Average keeping quality in days = 11.2
Maximum keeping quality in days = 17.0
Minimum keeping quality in days = 4.0

The keeping quality of unsalted butter during the course of one of the other competitions varied from five to twenty-five days, with an average of 12.6 days.

In the Table below the results for four of the competitors attaining the highest average marks for the scoring of five samples are compared with four having the lowest average judging score.

It can be seen that the first group attain higher average marks for farm inspection and butter making, whilst it is of interest to note that the average keeping qualities show a marked correlation with the score.

Code number.	*Farm inspection marks.*	*Butter making marks.*	*Average score.*	*Average keeping quality (days).*
X. 4.	28	136	84.8	12.2
X. 2.	51	140	84.2	12.4
X. 1.	52	158	84.0	12.2
X. 8.	29	158	81.4	13.0
Average	40	148	83.6	12.5
X.12	38	154	79.6	8.0
X.14.	32	166	78.6	9.2
X.11.	33	116	76.4	7.8
X.13.	27	116	75.2	9.4
Average	33	138	77.5	8.6

The relation between the judging score and the keeping quality is also shown in the following table :—

Judging score.	*Average keeping quality (days).*	*Number of samples.*
85 and over.	12.5	11
80 — 84.	11.9	25
75 — 79.	10.2	21
70 — 74.	8.3	3

It should not be taken for granted that a high score indicates a long keeping quality in all cases, however; several samples with a score over eighty-five only keep free from a discarding taint for five days.

Bacterial counts.

Forty grams or so are taken from the internal portion of the butter sample, melted and well mixed in Kali bottles at 45°C. Dilutions are carried out with saline warmed to the same temperature. Counts ranging from one million to a thousand million per gram have been obtained on gelatine incubated at 22°C. for forty-eight hours. The presence of liquifying organisms has varied from 5 per cent. to 40 per cent. of the total count. This group of bacteria are characterised by their fermentation action on protein; the changes brought about by them result in putrefaction, and the products set free by the process are very offensive from the point of view of flavour and aroma. When these gelatine liquifiers are present in considerable numbers in butter, they live on the casein that the washing and working process has failed to eliminate.

Bacterial counts are also made for comparison on standard agar at 37°C. and at 22°C.

A study is also being made of the presence of coliform organisms.

Mould and yeast counts.

Mould and yeast counts are made on Difco Malt Agar, acidified to p.H.3.5 by adding one cubic centimetre of 1% Tartaric Acid during plating. The reaction of the medium used is of primary importance, as it has been shown that the p.H. value of the medium has to be reduced to the region of 3.5 before the count obtained can with safety be regarded as consisting entirely of yeasts—bacterial colonies only very rarely develop at this acidity. The plates are incubated at 22°C for five to seven days and the comparative abundance of the following micro-organisms is noted :—

Moulds.
- Pencillium glaucum.
- Oidium lactis.
- Cladosporium sp.
- Less frequent species.

Yeasts.
- Saccharomyces sp.
- Torula sp.
- Mycoderma sp.

Mould counts ranging from 1,000 to 1,000,000 per gram have been obtained, Oidium lactis and Pencillium being generally dominant. Yeast counts over a million are quite common, the Pink Yeasts often forming the greater portion of the flora.

Bottle incubation test.

This test, which has been in use at some Australian Creameries is carried out as follows :—

Thirty grams or so of the internal portion of the butter are placed in a sterile Kali bottle, melted at 45°C, well mixed, incubated at 22°C, and examined up to seven days for abnormal odours. The melting and incubation intensifies any odour due to micro-biological causes. A control is carried out by heating a duplicate sample at 100°C for twenty minutes in a sterilizer. Any odour produced in the control can be generally set down to chemical causes. This test serves two purposes. First of all it serves as a check on the scoring, secondly it helps to show whether the microbiological counts are composed of an inert or undesirable flora. The latter type of flora often give rise to " musty ", " high acid ", " decomposed " or unclean odours.

Hydrogen ion concentration.

The reaction of the samples is tested on arrival and on discarding. A one to ten dilution of butter melted at 45°C is made and thoroughly mixed to make an emulsion. A clear layer obtained after standing is tested with Methyl red and Bromcresol purple.

Acknowledgment.

Grateful acknowledgement is made to Mrs. D. M. Davies, N.D.D., Senior Dairy Instructress at the University College, Aberystwyth, who carried out the judging and keeping quality determinations throughout the course of the three competitions, and in addition allowed the writer the use of all data pertaining to these tests.

A PRELIMINARY REPORT ON THE BACTERIOLOGICAL EXAMINATION OF FRESH CREAM AND ARTIFICIAL (RECONSTITUTED) CREAM.

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I. Introduction.

During the past four months sixty-two samples of fresh cream and reconstituted cream have been examined bacteriologically at this laboratory. Increasing quantities of the reconstituted article are being made, and now that the " Reconstituted Cream Bill " is being enforced, it is essential that the chemist and bacteriologist should be able to distinguish between the two types. Good reconstituted cream is indistinguishable from fresh cream either directly to the taste or when used in tea or coffee.

Richardson[1] states that " if 5 c.c. or 5 grams of the cream are shaken with a mixture of equal parts of Benzine and Methylated Spirit and the mixture centrifuged, the reconstituted cream will throw up its butter fat as an amber upper layer, whilst the fresh cream will remain as an emulsion with no appreciable separation of the fat layer. After strong centrifuging the reconstituted mixture shows three distinct layers, whilst the fresh cream mixture shows only two layers; the aqueous lower layer and an upper opaque stratum. The results are the same even when the cream has become sour ". He also states that the reductase action with methylene blue shows a decided difference.

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[1] Richardson, F. W. " Test for Reconstituted Cream ". *The Analyst*, Vol. 53, pp. 334-5. 1928.

Fresh cream of a good quality was obtained from several local retailers and examined at 15 to 17 hours old.

Artificial cream was sent to the laboratory in ice-packed boxes, and examined at 20-24 hours old.

The latter was the ordinary commercial product containing 42 to 45 per cent. butter fat.

The artificial product examined is made from spray dried milk powder and unsalted first grade New Zealand butter. The process is to put the necessary amount of water and milk powder into pure nickel tanks, raising the temperature by steam heating to 100°F. The unsalted butter is then added and the mixture brought to a *temperature of 145°F and held at this temperature for 15 minutes.* It is then emulsified and brine cooled to 40°F. Tanks, cooler, etc., are steam cleaned before and after use.

II. Microscopical examination of fat globules.

The size of the fat globules of several samples of artificial cream examined ranged from 5 to 10 microns in diameter. The globules are as a rule slightly more even and regular in size in the reconstituted product—as one would expect in a homogenized cream.

III. Microscopical examination of bacterial flora.

A series of slides were prepared from each sample of fresh and artificial cream. The smears were dried and afterwards placed in xylol to remove the fat. They were next immersed in alcohol to fix the milk solids and bacteria to the slide, then stained with methylene blue. The bacterial flora of the fresh cream is mainly composed of Streptococcus lactis, together with a few micrococci and Bacterium coli. The 24 hour old artificial cream has a much lower bacterial flora, composed mainly of short rods, a few Lactobacilli and Streptococcus lactis.

IV. Bacterial count.

The bacterial count per cubic centimetre on standard agar incubated for two days at 37°C. showed a considerable range of variation in both types of cream.

It can be seen that the average bacterial count of the fresh cream is practically forty times that of the artificial product. It is interesting to note that the plates prepared from the latter contained a fair amount of *aerobic spore forming colonies which spread over the surface of the agar.*

	Temp. on arrival. °F.	*Age on examination. (Hours).*	*Bacterial count per cubic centimetre.*	*Keeping quality at 60°F. (Hours).*	***Reductase test.* *Time taken ta reduce methylene blue.* *(Hours).***
Fresh cream.					
Average	54°	16	17,500,000	38	2.0
Maximum	62°		80,000,000	43	8.0
Minimum	50°		4,500	31	0.2
Artificial cream.					
Average	54°	20	496,000	56	8.2
Maximum	59°		4,600,000	63	10.0
Minimum	48°		1,200	47	5.5

V. Keeping quality.

The reconstituted cream, as was to be expected, has a longer keeping quality than the normal cream.

The artificial cream gave an average keeping quality of two and a quarter days (56 hours) during September and October as compared with one and a half days (38 hours) for the natural cream. The best keeping qualities recorded were two and a half days for the former and two days for the latter.

The taints developed on keeping were characteristic of the type of product. The fresh cream in all cases examined so far developed a sour taint, whereas the artificial cream *practically always developed a butyric or putrefactive taint.*

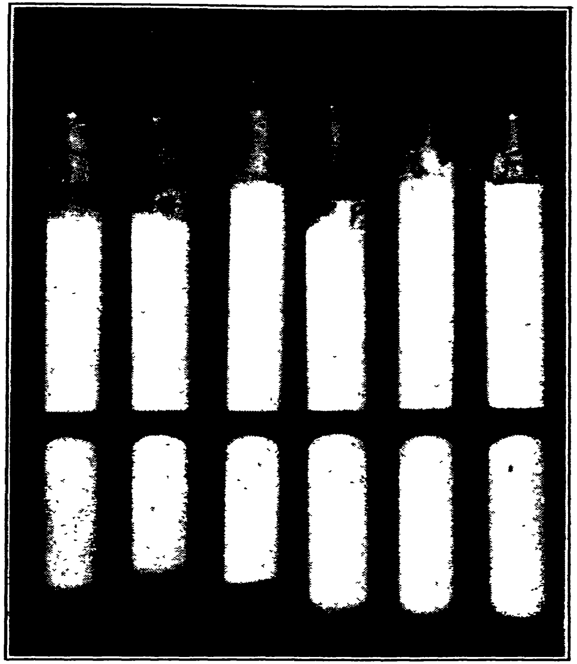
VI. Acidity.

The difference in keeping quality and in the taint led to the investigation of the acidity of the two creams at 24 hours intervals.

Average of daily acidities (twenty samples of each type).

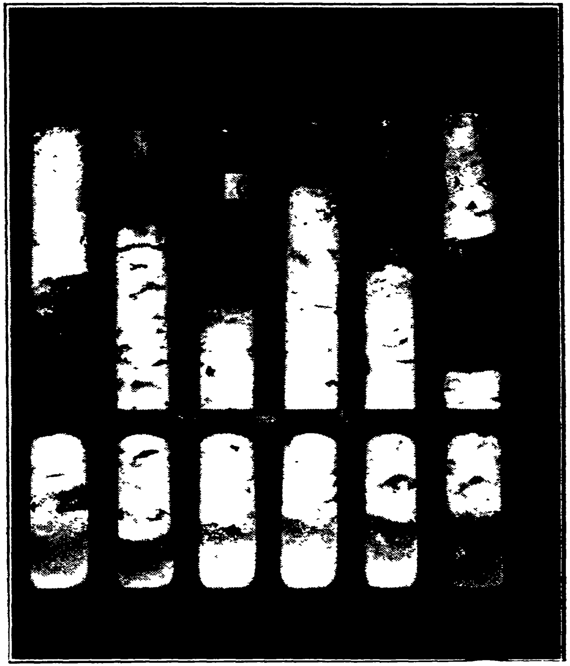
	Per cent. lactic acid Fresh cream.	*Per cent. lactic acid Artificial cream.*
24 hours	.08 %	.04 %
48 hours	.16 %	.07 %
72 hours	.26 %	.87 %

PLATE I.



Fresh Cream.
Fermentation Test—24 Hours.

PLATE II.



Artificial Cream.
Fermentation Test—24 Hours.

The artificial cream has a lower acidity at 24 and 48 hours old; a higher acidity is developed however on the third day. Microscopical examinations of both types of cream at the 72 hours old stage is being carried on at present, Lactobacilli being found in both types at this stage.

VII. Methylene Blue (Reductase) test.

The results for this test have been very interesting. In the case of fresh cream the time taken to reduce methylene blue (double strength) varied from fifteen minutes to eight hours—giving an average of two hours. The average is increased due to the fact that two samples took eight hours to reduce the dye. With the exception of these two samples the reduction took place within two and a half hours. The artificial cream, as one would expect with a pasteurized product, gave an average reduction time of 8.2 hours. With the exception of three samples, this type of cream retained the blue colour for seven hours (10 a.m. to 5 p.m.). The methylene blue test used in conjunction with the fermentation test might be used to distinguish the two types of cream in practically all the samples received. Of thirty-three comparisons made, four cases could not be differentiated by the methylene blue test alone.

Time taken to reduce methylene blue.	*Fresh cream. Per cent. samples.*	*Artificial cream. Per cent. samples.*
8 hours and over.	7	71
Between 2 and 8 hours.	22	25
Between ¼ and 2 hours.	71	4

VIII. Fermentation test.

The samples used for the Reductase test were kept at 38°C. for 24 hours. The type of fermentation set up in the two products were entirely different in nature. The fresh cream in all cases examined gave a clean acid clot, whereas the artificial cream was characterised by an excessively " blown " fermentation. (Plates I and II.) The gas formed in the artificial cream was considerable, and on occasions an inch or so of the clotted casein together, with the fat, was blown right out of the fermentation tube. Aerobic spore formers (Bacillus sp.) and anaerobic spore formers (chiefly Clostridium Welchii) were isolated from the latter. The organisms in the fresh milk curd were mainly Streptococcus lactis and Lactobacillus casei.

IX. Anaerobic spore test.

In view of the fact that anaerobic spore formers were found in the artificial cream, both types of cream were tested by means of the anaerobic spore test. Twenty cubic centimetres or so was placed in a test tube and covered with a half inch film of sterile olive oil and heated at 80°C. for ten minutes so as to destroy all but spore formers. The milk tubes were then cooled and incubated in anaerobic jars (pyrogallic acid and caustic potash method) for three days at 37°C.

Over 50 per cent. of the samples of artificial cream gave the typical positive " blown " or " enteritidis " fermentation, and Clostridium Welchii (B. enteritidis sporogenes) was found to be abundant. This type of organism has definite characters, being a fairly large rod, 1.6 to 4.8 microns long and about 0.8 microns thick. It is motile and Gram positive; terminal spores were formed in the cream, and these were of a characteristic drumstick (plectridium) form. Two of the fresh cream samples gave a positive reaction with this test.

X. Examination of milk powder.

The milk powder used in the manufacture of the reconstituted product has been found to be the main source of the anaerobic spore formers. Thirteen samples of the milk powder used have been examined. The bacterial count on standard agar ranged from 1,000 to 180,000 per gram, with an average of 31,600. A considerable number of spreading (spore-forming) colonies were developed on the agar plates. Approximately 75 per cent of the samples of milk powder examined gave positive results with the anaerobic spore test.

XI. Other tests.

Mould and yeast counts on acidified malt agar are being carried out at present, whilst the coliform organisms test has also been used.

XII. Conclusions.

A bacteriological comparison of fresh cream and artificial (reconstituted) cream has been carried out with the following results :—

(1) The bacterial content of the fresh cream (plate count on standard agar and direct microscopical method) is practically forty times that of the artificial cream.

(2) The average keeping quality of the fresh cream during September to December was 38 hours as compared with 56 hours for the reconstituted product.

(3) The fresh cream reduced double strength methylene blue in two hours. The artificial cream generally took eight hours or over to reduce the dye.

(4) The types of fermentation in the two products is very characteristic. All samples of the artificial cream gave a very stormy fermentation within twenty-four hours at 37°C. The natural product in all cases gave an even non-gassy curd.

(5) Anaerobic spore formers of the Clostridium Welchii group were detected in the artificial cream. These were traced to the milk powder used in manufacture.

Acknowledgement.

I wish to acknowledge my indebtedness to Mr. C. B. Singhal, B.Sc., and Miss A. Pugh for their assistance in carrying out a portion of the work.

DRY-ROT OF SWEDES.

SECOND PROGRESS REPORT.

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In a paper published in this *Journal* (4) the writer and Mr. W. A. P. Jones discussed in some detail the question of the initial cause of the serious outbreaks of dry rot in North Wales, and described their failure to find the disease organism on commercial samples of seed. In view of the importance of this point and the success claimed by Cunningham (1), considerable attention was paid to the matter in 1929 by the present writer, and the object of this communication is to place these later attempts on record although as yet no final conclusion is possible.

Laboratory experiments with seed.

In the following experiments with commercial seed, platings were made on nutrient agar after the seed had been surface-sterilised for ten minutes in 1 : 1000 Mercuric Chloride. The separate fungi developing on the plates were isolated and, together with the original plates, were kept for several months to give every chance for the growth of *Phoma lingam*.

Experiment 1. The seed left over after sowing a crop of "Halewood" swede which became severely attacked with dry-rot, was plated out in ten petri dishes of 100 seeds each. No Phoma developed on any of the plates.

Experiment 2. 1,000 seeds from a stock of " Model " swede on plating out gave negative results. A similar number were grown in soil sterilised at 20 lb. pressure in an autoclave, but no Phoma lesions were produced although the seedlings were kept under close observation until they were in the stage at which they would be singled in the field.

Experiment 3 (*a*). Through the courtesy of the National Seed Testing Station twelve samples of seed of the variety " Lord Derby " were secured. The variety was selected because it has consistently given the highest percentage infection with dry-rot in North Wales over a number of years. Since the samples came from widely separate parts of the country there was a likelihood that they included more than one distinct strain of the variety. Negative results were obtained by plating out 100 seeds of each of the twelve samples. (*b*) Four distinct strains of this variety were also secured through the courtesy of Messrs. Gartons of Warrington. Of these one (No. 106) was suspected by Messrs. Gartons of being somewhat contaminated with dry-rot, yet 1,200 seeds of this strain gave negative results on plates, as did also 100 seeds of each of the other three strains. (*c*) A further supply of the suspected strain was obtained for trial together with the same seed which had been sterilised with " Semesan " according to Cunningham's method for eradicating the seed-borne disease. A second strain (No. 51), not suspected of being infected, was also included for comparison. 500 seeds of each lot again gave negative results on plating.

Field experiments.

Experiment 4. Twenty drills, each 200 yards long, were sown with the same " Model " seed as used in Experiment 2 above; these alternated with twenty drills of the same seed surface-sterilised with 1 : 1000 Mercuric Chloride, and with sixteen drills of " Model " seed of different origin. The whole crop was kept under close observation and a careful inspection just before singling failed to reveal any seedling affected with the disease.

Experiment 5. The three lots of the variety " Lord Derby " mentioned under 3 (*c*) were sown in three plots of six drills each, the drills being 200 yards long and the order of sowing being changed midway along the drills. Again no sign of dry-rot could be found although the whole crop was examined just before singling; this is of particular interest since one of the untreated strains was definitely suspected of being infected.

Experiment 6. In order to test the importance of rotting roots as a source of an outbreak in the succeeding crop, seed from a stock of " Model " swede as used in Experiments 2 and 4 were sown under oats in the whole of a seven acre field which carried a badly infected crop of swedes in 1928. The seedlings were examined on May 28th with the result that six groups of infected seedlings were located, an old root with dehiscing pycnidia being found in every case besides the diseased group. One isolated infected seedling was also found without any apparent source of infection in the vicinity. Young plants of charlock showed no signs of the disease. When the field was again examined on September 20th, after the corn was cut, there was not only no evidence that the disease had spread but it was impossible even to locate the original infected seedlings.

Field variety trials.

Trials with six varieties of swede and one turnip were laid down on eight farms in Caernarvonshire and Anglesey; the seed in each case being drawn from the same stock. On some of the farms half the drills received farm yard manure and " artificials ", whilst the remaining half was dressed only with " artificials ". It was hoped in this way to gain information as to the importance of farm yard manure as a carrier of disease. Unfortunately the residual effects of previous dressings of dung—as was evident from the incidence of Finger and Toe—were such that little or no difference could be seen in the two sets of plots. On the other hand it is clear from the Table shown below that contamination from dung, whether freshly applied or not, was negligible.

The points of outstanding interest in these results are (1) the uniformly low infection of all varieties at most of the centres in contrast to the heavy infection of many of the same varieties sown in 1928; (2) the relatively heavy infection of three varieties at centre 3, and in one variety at centre 6; (3) the complete absence of dry-rot at the time of inspection at centre 2.

Discussion of results.

In the paper by the present writer and Mr. Jones, to which reference has been made (4), it was realised, of course, that although efforts to isolate the casual organism of dry-rot from seventy-two samples of commercial seed had failed, no amount of such negative evidence could prove the non-occurrence of the disease on swede seed. In view of the fact, however, that Cunningham (1) was only able to find a weakly parasitic form of the disease on English seed, in contra-distinction to the strongly parasitic strain he isolated from New Zealand seed, the opinion was expressed by us that, if seed infection occurred at all on English seed it was of little importance in causing outbreaks of disease in the field (4).

Since then the position has somewhat changed. Murphy, who at first was unable to find any trace of the disease being seed-borne (2) has now reported its occurrence in two samples of seed to the extent of 0.2 per cent. and 0.02 per cent. respectively (3). Buddin, working at Reading, has also reported (verbally to the writer) a number of successful attempts to isolate the fungus from commercial seed, the usual degree of infection being one diseased seed per four or five thousand. The fact that seed infected to an almost incredibly small extent is being put on the market must be accepted, and the only point at issue is the importance of this infection in causing field outbreaks.

Percentage dry-rot on eight farms in 1929.

Variety.	*Centres.*						
	1	*2*		*3*		*4*	
	B	*A*	*B*	*B*	*B**	*A*	*B*
Superlative ...	0.0	0	0	0	3	1.0	1.0
Magnum Bonum ...	0.5	0	0	11	24	3.3	10.0
Northern Farmer ...	2.5	—	—	1	17	—	—
Up-to-Date ...	2.0	0	0	0	3	—	9.0
Lord Derby ...	3.0	0	0	2	3	4.0	4.5
Danish Bangholm ...	8.5	0	0	0	2	2.0	—
Model ...	4.0	0	0	2	11	1.5	3.5
Green Top turnip ...	0.0	0	0	0	0	—	—

Variety.	*Centres.*					
	5		*6*	*7*	*8*	
	A	*B*	*B*	*A*	*B*	*B*
Superlative ...	3	2	6.5	3.0	0	0
Magnum Bonum ...	—	—	1.0	2.5	1	0
Northern Farmer ...	4	1	—	—	1	1
Up-to-Date ...	2	5	12.0	4.5	0	0
Lord Derby ...	—	—	7.5	2.0	1	1
Danish Bangholm ...	—	—	0.0	0.5	0	0
Model ...	4	4	2.0	1.5	0	1
Green Top turnip ...	0	0	0.0	—	0	0

NOTES :—

A —Plots dressed with " artificials " only.

B —Plots with F.Y.M. applied as well as " artificials ".

B*—At this centre both sets of plots had F.Y.M. and " supers ", but the " starred " plots had potash in addition and the land was badly water-logged.

Murphy and Hughes (3) have pointed out that, at most, this degree of seed infection would give rise to about 137 diseased *seedlings* per acre before singling—assuming that each infected seed produced a plant. After singling they consider that 4 per cent of the total possible plants would survive, from which it is clear that very few of the infected seedlings would be included in this number. Even so, it becomes necessary to assume a rapid spread of disease in the seedling condition with *either* the development of symptoms (which as yet the present writer has failed to find) *or* the continued normal growth of the infected plant up to the full development of the " bulb " before lesions appear (proof of which is lacking) before the final diseased condition of the crop can properly be attributed to seed infection.

If, for the sake of argument, we attach the fullest importance to this minute amount of seed infection by tacitly denying any other contributing cause, the average extent of infection thus due to diseased seed in the crops grown on the eight test farms in 1929 was 2.4 per cent. The maximum infection—if one excludes the B* plots at centre 3, where other factors were quite obviously operating—was 12 per cent. in one variety only at centre 6. Against this must be placed the total absence of disease at centre 2 when the crop was examined in December, as well as its absence in most varieties at centre 8. In all the centres the greater part of the disease was in an early stage of development, and it is evident that in 1929 at any rate, seed infection was of less importance than the unknown factors responsible for the spread of disease in the late autumn, *e.g.*, note the increase in the average amount of disease at centre 3 on the B and B* plots respectively.

In 1928 the results were quite different on the four test farms (4). Comparing the disease found in that year on centre B with that on centre D, the figures were respectively :—Superlative 39.6 per cent. and 1.0 per cent; Model 18.5 per cent. and 0.0 per cent.; Magnum Bonum 32.3 per cent. and 0.3 per cent.; Lord Derby 64.6 per cent. and 4.1 per cent. The slight attack in all varieties at centre D precludes any likelihood of unusually heavy seed infection being responsible for the severity of the disease on farm B. It follows that this slight infection at centre D was due to special conditions which prevented the spread from the very few originally infected seedlings, or that some source of infection other than seed was responsible on farm B for the severe loss in the mature crop. There is little doubt that seasonal factors were very largely so responsible, for the disease was far too widespread in 1928 for purely local cultural conditions to exercise a dominant effect. Yet other instances of even adjacent farms differing markedly in the amount of dry-rot in the crop show that local, as distinct from seasonal, conditions were of some importance.

To sum up the present position; the case against attaching much importance to seed infection as a source of serious outbreaks in the field is unsatisfactory, since it rests almost entirely on the failure to observe disease during the seedling stage, or indeed at any time before the roots are well grown. In New Zealand, however, the seedling disease is well known, and to a large extent the " gaps " in drills have been attributed to this cause. The only cases of disease in seedlings observed by the writer were the ones reported under experiment 6 above, where the infection was obviously contracted from adjacent rotted roots. The seed of the variety " Lord Derby " mentioned under experiment 3 (*c*) and 5, although one strain was believed by the seed merchant to be infected, showed no disease until September 20th when the older leaves on six plants developed lesions; these being evenly distributed between the three lots of seed. A final count in December gave 0.9 per cent. infection in the untreated suspected seed; 0.8 in the same seed sterilised with " Semesan "; and 1.0 per cent. in the strain not suspected of being infected in the seed. To connect this late appearance of disease with infection in the seed, it would seem necessary to assume that infected seedling leaves wither and fall to the ground, and that the fungus fruit-bodies remain dormant during the greater part of the summer, emitting their spores in early autumn and infecting the older leaves near the ground.

The evidence in favour of attaching importance to seed infection rests on more satisfactory grounds since, with its occurrence definitely established, it may be supposed that occasionally a heavily infected strain finds its way on the market. It is possible that this explains the epidemic of dry-rot in one district of Anglesey in 1928 where, as the writer has recently been informed, many farmers purchased the same seed locally at a low price. If it should prove that this seed produced a badly infected crop on *all* farms and that seed purchased from other sources gave a reasonably healthy crop, the case would of course be conclusive. A further fact supporting the importance of seed infection is that other contributory causes of serious loss such as contamination through manure or rotting roots in the soil, although certainly of importance, can hardly be responsible for widespread epidemics such as occurred in 1928. If, however, we exclude the likelihood of *heavy* seed infection, there can be no doubt that either seasonal or local cultural conditions are much more important than a one in four thousand seed infection, since they are responsible for enormously increasing the spread of the disease. It is this abnormally rapid spread which makes dry-rot of considerable economic importance in some years. On many farms seasonal factors are probably of most importance, but not on all, for there are instances of farms on which the disease occurs in a severe form every year, although even in these cases dry-rot is worse in seasons when the disease is widespread and less severe when, as in 1929, relatively little trouble has been experienced. It is proposed to continue work on the two aspects of seed infection and the factors responsible for the spread of dry-rot in the field. Damage by the swede midge frequently extends down the " neck " of the root and the possibility of dry-rot being spread by this midge has been considered. The writer, working on these lines in collaboration with Dr. W. M. Davies of this College, has so far found no indication that such a relation exists, but the possibility will be studied in greater detail during 1930.

The writer wishes to extend cordial thanks to the National Seed Testing Station, to Messrs. Gartons of Warrington, and to the many farmers who have given much assistance to him. In particular, acknowledgements are due to Mr. E. Jones, M.Sc., of Madryn Castle Farm Institute and Mr. G. L. Turner, the laboratory assistant, for the help they have given him.

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CONTROL OF ROOT FLIES IN SOUTH WALES.

By H. W. THOMPSON, M.SC.,
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The three vegetable pests, *Cabbage Root Fly* (*Chortophila brassicae*), *Onion Fly* (*Hylemyia antiqua*), and *Carrot Fly* (*Psila rosae*) cause considerable loss to growers in South Wales every year. The writer has frequently had his attention drawn to attacks involving the loss of 50 per cent. or more of a crop, sometimes on an area of several acres. The nature of the injury caused by the larvae or grubs of these pests is only too familiar to most growers in the area. The destruction of the roots of brassicae by the Cabbage Root Fly and the tunnels in carrots and onions caused by the larvae of the Carrot and Onion Flies respectively, usually followed by rotting of the affected plants, are very frequently observed, whereas in the past, measures for the control of these pests have been very inadequate.

During the summer of 1928, tests were instituted with the object of controlling these three vegetable pests. The tests were carried out in accordance with a scheme drawn up at the Plant Pathology Laboratory of the Ministry of Agriculture, prior to the conference of Advisory Entomologists in December, 1927. Before that time, a number of tests for the control of Cabbage Root Fly had been made in South Wales involving the use of Corrosive Sublimate Solution and a reasonable amount of control had been obtained by its use. The labour connected with the application, however, coupled with the fact that Corrosive Sublimate is a deadly poison, made this method rather undesirable for general use in this country.

In 1928, tests for the control of one or more of these pests were put down at the College experimental ground, St. Fagans, at Michaelston-y-Vedw, and at Drope, the substances tested and rates of application being :—

1. *Against Cabbage Root Fly.*
   - (*a*) *Naphthaline* (*Grade 16*) ¼ oz. per plant approximately.
   - (*b*) *Creosote and precipitated chalk* 1 part in 100, ¼ oz. per plant approximately.
   - (*c*) *Chlor-cresylic acid and precipitated chalk* 1 part in 100, ¼ oz. per plant approximately.

Applications were made on three occasions at ten day intervals commencing immediately after planting out.

Grade 16 Naphthaline is a refined form, finely flaked, which is particularly easy to apply as it remains dry and does not cohere.

The insecticides containing various chemicals and precipitated chalk were obtained ready mixed from an insecticide firm.

2. *Against Onion Fly.*
   - (*a*) *Naphthaline*, 2 oz. per square yard.
   - (*b*) *Chlor-cresylic acid and precipitated chalk* 1 : 100, 2 oz. per square yard.
   - (*c*) *Nicotine sulphate and precipitated chalk* 1 part in 12, 2 oz. per square rod.

Applications were made on three occasions at ten day intervals starting from the third week in May.

3. *Against Carrot Fly.*
   - (*a*) *Naphthaline,* 2 oz. per square yard.
   - (*b*) *Creosote and precipitated chalk* 1 part in 100, 2 oz. per square yard.
   - (*c*) *Nicotine sulphate and precipitated chalk* 1 part in 12, 2 oz. per square rod.

Three applications were made at ten day intervals starting ten days before thinning time.

The object of these applications was the prevention of egg-laying. Examinations of the experimental plots were made about five or six weeks after the last application of insecticide in each case. Counts were made of attacked and unattacked plants, doubtfully attacked plants being pulled up and examined. In the case of onions and carrots block samples were lifted and examined and at the College experimental plots the final crop was examined when lifted in addition, and counts made of affected and unaffected plants.

The attack of Root Flies on the test plots was light during the summer of 1928, consequently the figures obtained as the result of the examinations were not sufficiently definite. It was clear, however, as a result of these trials that Naphthaline was superior as a deterrent to the other chemicals used. It was determined, therefore, to put down further tests during the summer of 1929, using Naphthaline only against the Onion and Carrot Flies and Corrosive Sublimate Solution in addition against the Cabbage Root Fly.

One interesting point emerged from the Carrot Fly trial at the Green Farm in 1928. Although at the time of examination Carrot Fly was almost absent, when the crop was lifted quite a high percentage of the roots were attacked as shown below :—

Carrot Fly Plot at Green Farm—Examined at time of lifting.

	Naphthalene.	*Creosote.*	*Nicotine sulphate.*	*Control.*
Sound ...	292	262	220	250
Attacked ...	71	95	128	100
Doubtful ...	7	24	6	21

In the case of the numbers referred to as doubtful, the carrots were split and rotten, part of which trouble may have been due to other causes.

These carrots were very late owing to seed germination being checked by the severe drought which occurred in 1928. Apparently as a result of this they almost missed the first brood attack of Carrot Fly, but were affected by a later brood from neighbouring allotments. Although this late attack did little to reduce the bulk of the final crop it would certainly have a bad effect on the saleability. At Drope a similar late attack developed and the percentage of infested roots rose from about 5 per cent. at the time of examination to over 30 per cent. at lifting time.

Tests carried out during 1929.

1. *Cabbage Root Fly.*

(*a*) At Dinham, Monmouthshire, on one quarter acre of cauliflowers, variety " All the year round ". These had been planted out on June 10th and 11th, and applications of Naphthaline at the same rate as before were given on June 17th and July 2nd, *i.e.*, twice only. The plot formed part of a one acre piece. Another quarter acre received dressings of a proprietary insecticide made up almost entirely of lime, together with a small percentage of Naphthaline. This was applied to the plants on the same dates as the Naphthaline, but at the rate of about 8 cwt. per acre. This insecticide is sold as a guaranteed preventive of Root Fly attack. The remaining half acre was untreated and served as a control.

The plots were visited on July 22nd and August 22nd. 300 plants were examined on each plot. Sickly plants were pulled up and the roots examined. Healthy plants sure to reach maturity were regarded as unattacked.

Result.

	Control.	*Naphthalene.*	*Lime insecticide.*
Plants not attacked	129	300	141
Plants attacked	171	0	159

On each plot several plants were killed by cutworms. These were disregarded, such plants being noted as unattacked unless root examination showed evidence of Root Fly attack. Except on the Naphthalene plot, over half of the plants failed entirely as a direct result of Cabbage Root Fly attack. The lime insecticide had apparently no deterrent action on the fly, and in addition the unslaked lime contained in it had in some cases a decidedly scorching action on the stems of the plants, killing many of them.

In this case two dressings only of Naphthalene provided complete control.

(*b*) At Michaelston-y-Vedw, Monmouthshire.

A strip of three rows wide and 200 yards long was treated on a plot of about three-quarters of an acre of cauliflower. These rows were treated with Naphthalene on June 18th and 28th. The plot was examined and results estimated as before.

	Naphthalene plot.	*Untreated plot.*
Per cent. killed by Root Fly ...	7	72

On July 24th the grower ploughed in the untreated part of the plot and replanted it. The above figures show that in this case, as in the case at Dinham, two Naphthalene applications gave a satisfactory measure of control.

(*c*) At Troedyrhiw, Glamorgan. (Arranged in conjunction with the Glamorgan Horticultural Staff).

The plot at Troedyrhiw was two rows wide and 180 yards long, savoys and cauliflowers being the crop. In this case Corrosive Sublimate Solution was used in addition to Naphthalene, the solution being made up of 1 oz. Corrosive Sublimate in eight gallons of water, and about a quarter of a pint per plant was applied on the same dates as the Naphthalene. The applications were made on June 12th, June 22nd and July 2nd. Examinations of the plot were made on July 18th and August 12th—healthy and unhealthy plants being counted as before. Both the chemicals used undoubtedly gave a very considerable measure of control, but the results were rather confused by the prevalence of Clubroot (*Plasmodiophora brassicae*) on the plot, which made the examination of results difficult. The final estimates were :—

	Naphthalene.	*Corrosive sublimate.*	*Control.*
Per cent. attacked by Fly ...	3	9	23

The Corrosive Sublimate solution had a decided checking action on the Clubroot.

2. *Onion Fly Trials.*

(*a*) At the Glamorgan Demonstration Farm, Pencoed, in conjunction with the Glamorgan Horticultural Superintendent.

The variety was Bedfordshire Champion, sown on March 6th. Two beds of equal size about 20 yards apart were used and the same weight of seed sown on each plot. One plot was treated with Naphthalene at the same rate as before. The other was left as a control. Apart from the Naphthalene dressing the plots had identical treatment. The approximate dates of the applications of Naphthalene were :—May 4th, May 16th and June 2nd, and examinations were made on June 29th and July 20th.

As before, any plants which appeared unhealthy at the time of inspection were lifted and examined for Onion Fly attack. On the Naphthalene treated plot three affected plants only were found. On the untreated plot the onions which failed were so numerous and they rotted down so quickly that results were arrived at by examination and estimates from corresponding lengths of rows in the two plots. The results obtained showed that on the untreated plot at least 75 per cent. of the plants had failed entirely as a direct result of Onion Fly attack, whereas on the treated plot the failures amounted to considerably less than 1 per cent. The photographs appended show the difference in appearance of the two plots. Every plant failed in one row on the untreated plot.

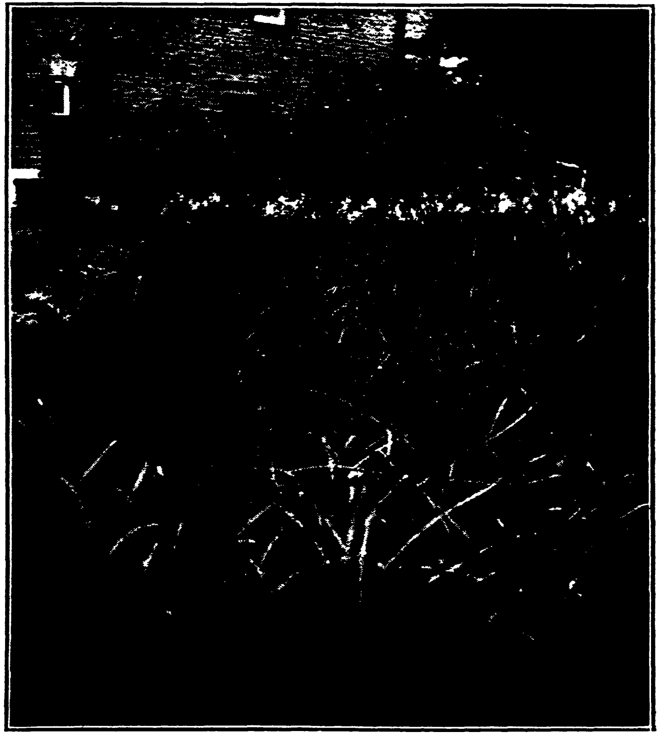
(*b*) A similar trial on Onion Fly Control on the College experimental ground failed to give results of value owing to the slightness of infestation.

3. *Carrot Fly Trials.*

(*a*) At the Green Farm, St. Fagans. The variety Red Intermediate was sown on April 13th, and Naphthalene was applied on June 8th, June 18th, and June 28th. Examination of the plots was carried out five weeks after the last application. The percentage of plants attacked was too low to be of value but here again the number attacked at lifting time was moderately high.

	Naphthalene.	*Control.*
Total number of plants examined at lifting time	693	494
Number attacked by Carrot Fly	88	76
Per cent. attacked by Carrot Fly	12.7	15.4

The amount of difference in the attack on the two plots is not sigificant but again it shows that a later brood of Carrot Fly may cause considerable injury. It is regarded as extremely probable that by using Naphthalene the crop can be safeguarded against the attacks of the earlier brood of Carrot Fly which might



1.
Treated with Naphthalene.

2.
Untreated.

be likely to cause crop failure. The later brood attack is likely to have less severe results.

(*b*) In a test against Carrot Fly at Pencoed, the control had fifteen plants infested, the Naphthalene plot three plants, and a plot treated with Chlor-cresylic Acid and Precipitated Chalk was clear. Here again, as in the case of a further test put down in 1929, the infestation was too light to yield really conclusive results from the trial.

Carrot Fly has been decidedly less prevalent than usual during the summer of 1929 in South Wales.

Conclusions and Notes on the Trials.

The results obtained from these trials, whilst not so complete as might be desired, do appear to have demonstrated clearly the value of Naphthalene as a deterrent against the three pests. The trials. especially those at Pencoed, Michaelston-y-Vedw and Dinham have aroused a considerable amount of local interest. Two large growers have taken up applictions of Naphthalene as a routine measure, and many of the Glamorgan Allotment-holders' Associations are making arrangements to do likewise during the coming year, and have ordered Naphthaline in bulk for the use of their members.

Flaked Naphthalene, which should give equally good results as that tested, is obtainable locally for 12s. per cwt.

It seems clear that two dressings of Naphthalene may, in certain cases at any rate, give a satisfactory control of Cabbage Root Fly.

Results show that a minor amount of injury may develop on carrots owing to a late attack of Carrot Fly, but this is not considered to be very important—Naphthalene being likely to prevent the earlier and more severe attack.

ABSTRACTS, REVIEWS, AND BIBLIOGRAPHICAL NOTES.

AGRICULTURAL ECONOMICS.

Abstractors:

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ACCOUNTS AND COSTS.

Economic and Financial Results on Three Arable Sheep Farms, 1924-25, 1925-26 and 1926-27. Accounting Studies No. 1.

Economic and Financial Results on Five Dairy Farms 1924-25, 1925-6 and 1926-27. Accounts Studies No. 2.

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In study No. 1 the results of three arable sheep farms have been analysed. One farm is in Bucks, one in Dorset, and one in Hampshire. The acreages range from 307 to 460 acres. Figures based on the average of the annual valuations made from 1924 to 1927 on each of these farms show that sheep represent 31.4 per cent. on farm A, 70.4 per cent. of farm B, and 33.8 per cent. on farm C of the capital invested in livestock, implements and machinery.

The method used in these reports does not show " profits ", but the " surplus " which each department of the farm contributed to meeting overhead charges and to final profits, or instead of departmental losses the amount by which the direct costs exceed the direct returns of the department. There has been a considerable consecutive annual drop both in the " surplus " per acre and per 100 ewes on all the farms. Only on one farm was a surplus registered in each of the three years. In the case of the other two farms, a deficit was shown for the third year; direct costs were greater than direct returns without allowing for overhead charges.

On all the three farms there has been a slight tendency towards increased costs per 100 ewes due mostly to an increased feeding stuffs bill (both home grown and purchased). On the whole the results from sheep have been less satisfactory throughout than the results from sale crops.

The total payments and receipts per acre over all departments on a three years average are as follows:—

Payments.	£	s.	d.	*Receipts.*	£	s.	d.
Rental	0	16	6	Crops	2	6	2
Wages	1	14	10	Sheep	1	15	2
Feeding Stuffs ...	0	14	8	Cattle	1	11	5
Manures	0	8	1	Pigs	0	11	0
Livestock	0	14	7	Other receipts ...	0	8	8
Other expenses ...	1	15	2				
Total ...	£5	18	10	Total ...	£6	7	11

The summary of the financial results of the three farms from 1924-27 per 100 acres, including all activities, shows a net surplus (profit) of £178 on farm A, £54 on farm B, and a loss of £87 on farm C.

In Study No. 2 the results of five dairy farms are analysed to illustrate some of the main problems that have confronted dairy farmers during the three years from 1924 to 1927. Two of the farms are in Berkshire, two in Dorset, and one in Bucks, and the acreages range from 124 to 498.

The total receipts, of which sales of dairy produce is the most important item, range from £8/7/5 to £25/3/4 per acre and total expenses from £8/9/1 to £24/10/7 per acre. For the period 1924-27 there is a loss of £2 per 100 acres on farm F and a net surplus (profit) of £159 on farm G; £227 on farm H; £110 on farm J and £31 on farm K.

The results of milk production per cow per annum are given for seven farms. The average surplus for the years 1924-27 show a range of from £4/8/11 to £26/19/6 per cow per annum. Production costs (excluding delivery costs) for the same farms vary from £12/11/1 to £47/14/7 per cow per annum and the food bill accounts for the bulk of the costs.

From the figures given in the Report, there does not appear to be any close correlation between the average milk yield per cow and the average weight of concentrates fed.

The average number of hours of manual labour worked per cow per annum vary from 179 to 458, but in five out of seven cases the number of hours worked on cows directly is between 200 and 260 per annum.

Studies No. 1 and 2 contain detailed statistical evidence on the cost and seasonal distribution of horse and manual labour. J.P.H.

Four Years Farming in East Anglia 1923-1927.

Report No. 12. R. M. G. CARSLAW, Farm Economics Branch, Cambridge School of Agriculture.

During the past four years bi-annual reports dealing with the costs and returns on East Anglican farms have been issued by the Farm Economics Branch of the School of Agriculture, Cambridge. The results have now been amalgamated and presented in Report No. 12. In this publication every branch of farming is dealt with, and a careful analysis is made of the four years results obtained on twenty-six farms in the eastern counties.

The combined results from both dairy and fattening cattle show a loss of 14 per cent. or 4.3 per cent. if credit is given for manurial values. The author attributes this loss on the amalgamated cattle account principally to beef production as on the farms where the sale of milk was the objective and especially where this was retailed by the farmer there are profits shown. In two out of the four years there was on the average a profit on pigs and in all years a profit was made on poultry. Out of the twenty-six farms only five kept sheep and an analysis of the sheep results on a yearly basis shows that profits were only achieved in 1924 and 1925. Contrary to the popular impression crops have been more remunerative than livestock, and taking all crops together there is a profit shown. For all the farms the average net profit is 16s. 2d. per acre *of crops and grass*, but when an allowance is made for the estimated value of unpaid family labour and interest on occupiers' capital at the rate of 5 per cent., this profit is reduced to a loss of 8s. 8d. per acre of *crops and grass.*

This is an extremely useful and valuable report, and can be confidently recommended to all those interested in the financial side of farming. J.P.H.

Livestock Production Costs in Greene County, Ohio.

JOHN F. DOWLER. *Ohio Agricultural Experiment Station Bulletin* 419.

This bulletin sets forth in detail the results obtained by analysis of data collected from twenty-five farms for a period of five years 1920-24. The data was collected on a " full costings " system; each farm being visited by the investigator once a week.

The production of livestock and livestock products accounted for 72 per cent. of the farm receipts; wheat was the only important cash crop. Maize occupied about 30 per cent. of the cultivated area and it was utilised mainly for producing pork. The sale of pigs made up 50 per cent. of the total farm receipts.

Tables are provided showing in detail cash cost and percentage distribution of the factors in cost for pigs, cattle, sheep and poultry. In addition good use is made of the data relating to hours of labour, weight and kind of food used, suitability of equipment, etc., which are related to returns in the form of meat, butterfat and eggs produced. The variations in methods and results found from farm to farm are examined.

The study provides useful suggestions as to the method of handling the large amount of data obtained from full cost studies relating to livestock. J.Ll.D.

Milk Production. Five Years Costs and Financial Results.

Report No. 7. JAMES WYLLIE, South Eastern Agricultural College.

This is a very interesting publication on the economy of milk production and is a continuation of Reports 1 and 2, which dealt with the results for the first two years of the investigation, 1923-24 and 1924-25.

During the five years ended Michaelmas, 1928, the production of 1,415,189 gallons of milk on twenty farms in the south-eastern counties resulted in a total loss of £4,235, equivalent to an average of 38/- per cow or 0.7d. per gallon on an average yield of 647 gallons per cow per annum, before reckoning either interest on capital or managerial salaries.

When the farms are divided into groups these are the results. Group 1—five farms showed an average profit of 112/- per cow per annum or 2.1d. per gallon; Group II—eight farms, a loss of 72/- per cow per annum or 1.4d. per gallon; and Group III—a loss of 174/- per cow per annum or 3d. per gallon. Group III consisted of farms on which the occupier was not entirely dependent upon farming for a livelihood. Groups I and II consisted of *bona-fide* full time farmers with one exception and while the results varied, the average of these two groups showed a profit.

The five farms in Group I showed profits of £979, £659, £917, £1,078, £1,012 for the five years 1923-24 to 1927-28 respectively. The gross return on the capital invested in the dairy stock and equipment was 10.1 per cent. per annum, with a range of from 5.4 per cent. to 14 per cent. per annum. Detailed results are given for these farms, as they were the only farms that were included in the invstigation for the whole period. For Groups II and III only a brief summary of the results are given.

Of the five farms for which records were obtained for the five years, it was found that the farm which gave the best return on the capital invested was stocked with cows whose average milk yield was 555 gallons per annum. The other farms had considerably higher yield and averaged nearly 700 gallons per annum. The author points out that the relationship between the average milk per cow and profit is not as close as it is commonly thought to be. Another interesting fact which emerges from this report is that producers have been able to maintain their profits by a more efficient management of their herds; for example, by reducing the food consumed per gallon of milk.

The author emphasises the need for some effective system of controlling the feeding of the cows and other dairy stock, and suggestions are made for the setting up of a food recording scheme as a necessary complement to a milk recording scheme. J.P.H.

Sugar Beet. Cost and Returns for the year 1927-28.

A. BRIDGES and J. R. LEE, Oxford Agricultural Economics Research Institute.

This report presents the summarised results of the fourth year of the inquiry into the costs and returns from sugar beet growing undertaken by the Institute at Oxford. The present enquiry covers an area of 5,640 acres, and returns have been obtained from 448 farms distributed over fifteen districts in England and Wales. Owing to the effect of an unfavourable season the results for 1927 were very disappointing and nine out of the fifteen districts failed to show on the average a cash profit.

The statistical returns received from two district groups differed to some extent from those received from other areas and the figures for these are shown separately in the report. The returns from the other 407 farms show an average direct cash profit of 5/6 per acre and £2/12/10 per acre when the value of residues are included. On a tonnage basis the cash profit was 9d. per ton and 7/- per ton (including residues).

As in previous years a classification of the costs by soil groups and by geographical area has been made. Attention is drawn in the report to the fact that in each of the four years covered by this investigation over 50 per cent. of the gross expenditure on the crop has been incurred in providing the necessary labour. Thirty per cent. of the gross expenditure represents direct wages payment to farm workers.

The influence of the date of sowing and the effect of row spacing are dealt with. It is deduced that by sowing before the 10th of May growers enhanced their prospects of a profitable crop by 26 per cent., and it is found that narrow row spacing seems to be more effective in producing better yields on the heavy than on the light soil. Direct application of farm yard manure resulted in an increase of 14 cwts. per acre in the yield of beet, but the direct cost of the dung exceeded the value of the beet except in the case of the light soil group.

A preliminary statement of the costs and returns for the 1928 crop is also given. The results show an average cash profit of £2/17/4 per acre or 6/5 per ton, and £4/19/3 per acre or 11/1 per ton when residual values are added. J.P.H.

Sugar Beet Growing; The Economics of. (Three Years Yorkshire Records).

A. G. RUSTON, Leeds University.

A summary of the costs and returns from sugar beet growing in Yorkshire is given for the years 1922 to 1928, with more detail for three years. Only in 1926 was the washed beet produced at less than £2 per ton.

The author is of the opinion that there is little hope of reducing the cost much below its present average figure of approximately £17 per acre, and that if the beet crop is in the future to leave a reasonable return to the growers the price paid by the factory for clean beet must not be allowed to fall much below 50/- per ton. Since the granting of the Government subsidy in 1925 the crop has each year left a good return. It was particularly profitable in the favourable season of 1926-27, and more than held its own in the unfavourable season of 1927-28. There has been a decrease in the freightage cost, due to the increase of factories in the counties.

The increased economic returns in 1926 as compared with 1925 were apparently due to four main causes:—

1. An increase in tonnage of 19 cwts. per acre.
2. An increased sugar content of 1.4 per cent.
3. A reduction of £1/16/9 per acre in the charge for rail freightage.
4. A reduction of £1/11/7 per acre in the cost of farm yard manure applied.

Figures extracted from labour-time sheets show the labour requirements of sugar beet as compared with other farm crops:—

	Man Days per Acre.
Carrots	31.3
Potatoes	27.3
Sugar Beet	23.2
Mangels	20.3
Wheat	7.6

In 1927 the cost of labour (man, horse and tractor) was £9/3/4 per acre and £1/8/4 per ton, or about 55 per cent. of the cost of growing the crop (including freightage and less cleaning and residual values).

A classification of the costs for certain years has been made by soil groups, preceding crops, crops grown on ridge or flat. The date of drilling and singling and row spacing as effecting yields and the comparative returns from sugar beet as compared with other crops are commented upon. J.P.H.

Sugar Beet in the Eastern Counties, 1928.

Report No. 13. C. Burgess, with some observations by G. Ll. Rogers, Farm Economics Branch, Cambridge School of Agriculture.

This report presents the results of the second year of the Cambridge inquiry into the financial and economic aspects of sugar beet growing on East Anglican farms. Results have been obtained for 100 farms. As compared with 1927 better profits were made in 1928. The total cash cost was £21/8/0 and the net cost £17/4/0 per acre. In 1927 the cash profit per acre was 5/5 and when an allowance was made for the value of tops, residual values of cultivation and manures, the net profit was £4/4/1. In 1928, the cash profit was £2/16/4 and the net profit £6/19/9. Other facts emerging from the report indicate that no apparent advantage is gained by the use of farm yard manure and that an extension of the practice of subsoiling is desirable. Seeding of not less than 15 lbs. per acre has given better results than lighter seedings and the fields drilled before the 1st May show an increase of nearly 2¼ tons of beet as compared with those drilled after the 19th of that month. Again, distance between the drills of 19 inches and under show

higher yields than those of 22 inches and over, but there is no significant difference in the yield when ridge or flat work is pursued.

To all those interested in the growing of sugar beet this report provides a useful study. **J.P.H.**

FARM MANAGEMENT.

Agricultural Machinery; A Survey of Trade in.

Eleventh Report. Imperial Economic Committee, 1929.

This survey is confined to the trade in machinery for producing and harvesting the standard crops of the temperate zones. The four principal exporting countries are the United States, Canada, Germany and the United Kingdom. Of these four countries the United States did a greater export trade (over £9 millions) than the other three countries put together. The European import market was the largest, £5 millions, though closely followed by South America; these two markets together exceeded all the rest of the world. Imports into Russia exceeded £1¼ millions, of which £24,000 was of United Kingdom manufacture. Germany supplied imports to Russia to the value of over £1¼ millions. The Russian import market practically equalled that of Australia, New Zealand, South Africa and India put together.

Careful investigations were made as to what extent manufacturers in Canada and the United States had an advantage over those in Europe, owing to similarity of agricultural practice in their own countries to that in South America, South Africa, Australia and New Zealand. The trade evidence on this point was very definite. It is a mistake to assume that foreign markets, even with approximate similar climatic conditions, will demand duplicates of the local patterns. The trade goes to the country which most closely satisfies local requirements both in design, in service for repairs and in methods of sale.

The survey includes a good deal of detailed statistical matter; it also touches upon the factors controlling the industry in the more important markets. C.A.S.

Dairy Farm Management; A Survey of Farms in the Waikato and Taranaki Districts, Season 1926-27.

E. J. Fawcett, New Zealand Department of Agriculture.

This contains the detailed results of a survey of about 200 dairy farms in New Zealand. Tabular and graphical methods of presentation of material are used to good effect throughout when dealing with problems such as the relation between the size of farms and stock carrying capacity; size of farms and production of butterfat per cow and per acre. The study gives a complete analysis of costs and returns on these dairy farms and endeavours to establish the causes of variations in the efficiency of the different groups. In order of importance the factors influencing profitability are given as (1) Management; (2) Working capital available; (3) Natural fertility of the soil; (4) Climatic conditions. To improve results on these dairy farms the report suggests (1) Increased carrying capacity; (2) Increased production of butterfat per cow; (3) Farming of an economic area.

Appendices are added which include a copy of the survey forms used and a statistical proof of the correlations shown in the body of the report. J.Ll.D

Seasonal Unemployment in Manitoba.

R. W. Murchie, W. H. Carter and F. J. Dixon.

This report deals with seasonal fluctuations in employment in different industries in the Province of Manitoba, primarily in its effect on seasonality of employment in the city of Winnipeg. But it shows the importance of the farms in the total demand for labour and in regularity of employment.

Section 3, which deals with the seasonal demand for agricultural labour provides a good picture of farming in this area. On the majority of farms production consists almost entirely of small grains. This gives rise to extreme seasonality in demand for labour, and at harvest time the farms absorb all the surplus labour of the cities and even withdraw some labour from other industries, in addition to a substantial supply which comes regularly from the eastern provinces. Many of these temporary farm workers drift back to the towns and cities in the winter months to swell the ranks of unemployed workers there.

Although there is a greater demand for labour during the summer months in the building, transportation and manufacturing industries the greatest contributing factor is the unequal demand from farms at different seasons.

The authors point out however that farming in the Province shows a tendency to become more mixed in character and this fact coupled with the gradual introduction of the combine harvester will serve to spread the farm demand for labour more evenly. The report also contains useful suggestions as to the methods that should be adopted by public bodies and private employers to aim at better dovetailing of work between different industries at different periods of the year and to ensure better regularity of employment within industries. The use of agricultural resources and farm management play an important part in the social economy of use of labour. J.Ll.D

The Combined Harvester-Thresher in the Great Plains.

L. A. Reynoldson, R. S. Kiper, J. H. Martin and W. R. Humphreys.
Technical Bulletin No. 70, U.S.D.A., 1928.

The object of the study was to determine the practicability and cost of harvesting grain with a combine. Detailed investigations were made into farming conditions and types of combines used in selected districts in Texas, Oklahoma, Kansas, Nebraska and Montana. The combines varied in size from an eight foot cut to a twenty foot cut. The first combines to be introduced were horse-drawn and the threshing plant derived its power from a large ground wheel. In some cases these cut a swath forty feet wide and required thirty-six horses and a crew of five men. Later models were equipped with an engine which propelled the machine and supplied power for the threshing plant. A later type consists of small combines, horse or tractor drawn, with an auxiliary engine to drive the thresher. The more recent type introduced in 1926 cuts a swath of eight feet to ten feet, and is drawn by a tractor with a direct power drive from the tractor itself. This is cheaper and requires a smaller crew than the auxiliary power type, and can be used on farms with small wheat acreages, as well as for crops other than wheat.

It was found that the use of combines give the following advantages:—

(1) Lower harvesting costs.
(2) Reduction in labour requirements.
(3) Shorter harvesting and threshing period.

The rate of travel varied between 2.5 and three miles per hour. The size of machine has no effect on the rate of travel. Acres cut per hour ranged from 1.6 for eight foot machines to 4.5 for twenty foot machines.

The average requirements in quantities and costs per acre were as follows:—

Fuel 1.4 gallons.
Man labour 45 minutes.
Repairs 10 cents (= 5d.).
Depreciation 44 cents (= 1/10).

For small acreages a combine is more costly than binders or headers, but above 160 acres combines of various sizes which give lower harvesting costs than with either binders or headers are available. The larger the acreage the higher the margin or saving in favour of combines.

Comparative costs per acre using different methods of harvesting and threshing were:—

10 foot combine	...	$1.47 (6/1½).
15 foot combine	...	$1.50 (6/3).
12 foot header	...	$3.36 (14/-).
7 foot binder	...	$4.22 (17/7).

Comparative harvesting losses in terms of per cent. of total yields were:—

	Combines.	*Headers.*	*Binder.*
Harvesting	2.6 per cent.	3.3 per cent.	6.6 per cent.

The average threshing losses with combines amounted to 1.9 per cent. of grain threshed compared with 1.2 per cent. with stationery thresher.

A ten foot combine should harvest 375 acres in fifteen days, and the fifteen foot combine should harvest 525 acres. The maximum for a ten foot combine is about 640 acres in this time and for the fifteen foot combine 1,100 acres. Custom cutting may enable farmers with small wheat acreages to invest profitably in a small combine. T.L.

FARM SURVEYS.

An Agricultural Survey in South Devon.

R. J. CURRIE and W. H. LONG of Darlington Hall, Totnes, and Seale-Hayne Agricultural College, Newton Abbot, Devon, in collaboration with the Department of Agricultural Economics, Cornell University, New York State, U.S.A. 204 pages, 365 tables and twenty-eight illustrations.

This work represents the result of a survey of 205 farms. The materials were taken to Cornell University for compilation.

The average size of these farms was 128 acres with 40 per cent. arable land; 69 per cent. of the farms were under 150 acres while the average rent of all farms was £191.

Capital invested in livestock, implements and machinery was, for each farm, £1,093, representing £8/10/9 an acre. The total sales " per 100 adjusted acres " were £619.

The following table illustrates the average distribution of farm receipts and expenses for these 205 farms, which extended over seventeen parishes:—

Receipts.

	Amt. per farm	%
Dairy products	£234	31
Cattle	177	23
Crops	82	11
Sheep	68	9
Wool	22	3
Pigs	67	9
Eggs	54	7
Cider	11	1
All other	52	6
Total	£767	100

Expenses.

	Amt. per farm	%
Labour	£205	29
Rent	191	27
Feeding Stuffs	126	17
All other	196	27
	£718	100

It will be seen that there was an average balance over expenditure of £49 each farm for the period under review (1927-28). The farms averaged ten milking cows with a milk-equivalent sale of 505 gallons each cow. Sales of dairy products each cow amounted on an average to £23. The number of lambs each ewe was 0.8 whilst egg sales were 10/- each hen. The butter making farms purchased an average of £105 of feeding stuffs and the farms selling some of the dairy products as milk £156, with an average for feeding stuffs for all farms of £126. The value of purchased fertilizers each 100 acres was £29, but for the average of the ten best farms £25.

C.A.S.

Celery Production and Marketing in the Isle of Axholme.

ARTHUR JONES and S. M. MAKING, Midland Agricultural College.

Celery growing in the Isle of Axholme is generally supposed to have been introduced in 1880. The crop requires soil of deep, friable and easily worked nature, with a plentiful supply of underground moisture and climatic conditions of spring and early summer showers and warm sunny growing period. These conditions are found in the Isle.

Generally speaking the growers may be grouped in one of those classes, (1) Those who grow celery as one of a few main crops; (2) Others who include celery in their arable scheme; (3) Those who grow celery as a side line. The survey makes a detailed study of each of these classes.

There is an interesting practice called " growing celery at half part ". The " grower " supplies the plants and manual labour; and the " farmer " provides the land and horse labour; the product is shared between these two principals on agreed terms.

Among the various production problems discussed in the survey is that of meeting the difficulty and cost of obtaining yard manures from the town. It was found that 30 per cent. of the total prime costs of celery growing is accounted for by farm yard manure. As it is almost impossible to increase the number of stock kept on the land it is suggested that the applications of such manure be reduced and an artificial substitute be used. This could be done on the peat soils.

The disposal of the crop by the grower is through one of the two main channels, either local sale or sale in a distant market.

Most of the small growers (unless they are producer-dealers) sell locally, as a rule to local dealers. The larger growers and a few small growers sell to distant markets, either through local commission agents, through a market commission agent, or direct to wholesaler.

Grading and standardisation by the growers is suggested as a much needed market reform. Too little attention is paid by the growers to the appearance of the celery when it leaves their hands. Better prices could be obtained especially for the better quality celery if it were marketed under the most advantageous condition. W.H.

The Beef Cattle Industry; Economic Aspects of.

EDWIN C. VOORHIES and A. B. VAUGHAN. *California Agricultural Experimental Station Bulletin* 461, 1928.

After a brief review of world conditions, and of the situation of the cattle industry in the U.S.A. this Bulletin proceeds to analyse the situation in California relative to the general background of world production. Between 1920 and 1928 the cattle population of the U.S.A. declined by 23.8 per cent. In that country the cattle population is subject to cycles varying from fourteen to sixteen years in duration. High points were reached in 1904 and 1918 and low points in 1912 and 1928. In the latter year the number of cattle on farms was lower than at any period since 1900 with the exception of 1912. Since 1900 the number of cattle per capita has declined about 18 per cent. and the slaughter of cattle about 10 per cent. The per capita slaughter of calves has increased by about 30 per cent.

The decline in the number of beef cattle has been greater for total cattle, whilst milk cows have actually increased in numbers. A feature of the last few years has been a widening of the spread of market values between good and poor grades of beef cattle, and this has resulted in the requirement of more care being taken by producers to market better finished cattle of lighter weights. The level of cattle prices since 1923 has been higher in the U.S.A. than in other countries. Farmers are advised to increase their herds conservatively as there is no room for as great an expansion in the industry as there has been at times in the past, and it is forecasted that prices are likely to fall after 1930 or 1931.

T.L.

PRICES IN AGRICULTURE.

Prices of Fertiliser Materials and Factors affecting the Fertiliser Tonnage.

EDMUND ELLSWORTH VIAL, Cornell University. *Memoir* 719.

An elaborate and effective historical examination of the factors that have influenced the course of prices and production of fertilizers in the United States. Phosphates, Potash and Nitrogenous manures are first treated separately and an index number of prices for each section is compiled, weighted according to the tonnage of each variety produced within the section. The weighted index number of prices for Phosphoric acid is given as 97 in 1897; 95 in 1913, and in 1927, 101. For Mineral nitrogenous fertilizers for the same years the relative figures are 74; 106; and for organic Nitrogenous manures the index numbers are 59; 97; 186. For Potash manures, a large proportion of which have to be imported, the index numbers read 95; 103; 93. For the five years 1922-26 Phosphatic manures averaged 105 per cent. of pre-war prices; Mineral Nitrogenous manures 100 per cent. and Potash 83 per cent. Potash has been consistently cheaper than the other fertilizer ingredients.

From the separate indices of prices of Phosphatic, Nitrogen and Potash manures a general fertilizer index number is compiled which shows a rise in fertilizer prices from 1898-1907 and a decline from 1908-14. For the period 1922-26 the prices of fertilisers averaged 107 per cent. of the pre-war level. The conclusion is that " Fertilizer materials have been and still are very cheap in comparison with other commodities ".

The section dealing with consumption of fertilisers on American farms shows that for the period 1900 to 1914 the tonnage utilised was increasing steadily. During the twelve years 1914-25 there was no consistent increase in the tonnage although large fluctuations occurred from year to year.

In the concluding chapter the factors which influence yearly fluctuations in fertilizer consumption are examined statistically. The conclusions arrived at by methods of multiple correlation are that the value of the cotton and tobacco crops per acre in the previous year are responsible for 60 and 22 per cent. respectively of the fluctuations in prices, while factors such as the value of potatoes and the purchasing power of fertilizing materials are of minor significance.

A statistical appendix extending to fifty pages shows in detail the yearly and monthly prices of tonnage produced and imported of each of the main types of fertilizers.

This is an exhaustive and valuable piece of work and should be extremely useful and suggestive to investigators of the same or similar subjects in this country. J.Ll.D.

The Value of Gold; Farm Prices and.

J. R. Commons. *North American Review.* January-February, 1928.

This paper deals with the monetary aspects of agricultural relief problems in America. After illustrating the monetary influences on prices since 1919 the writer examines the peculiar position of agricultural as contrasted with industrial producers. The latter have enjoyed a higher level of prices than the former and this is attributed in part to greater control over production, in part to the protection given by tariffs. Farmers on the other hand have no protection in foreign outlets for their produce and yet must submit to Federal control over the volume and price of money. Variations in discount rates and purchases of Government bonds have brought about periods of rising and falling prices since 1919.

A central problem is the balancing of industrial and agricultural interests, *i.e.*, what price policy is to be adopted? After discussing the limitations of orderly marketing and tariff reduction as means of relieving the agricultural position in U.S.A., the writer dwells on the handicap which war debts impose on Europe's demand for American products, and on America's position as holder of the world's gold reserves. The opinion is expressed that too much responsibility is placed on the shoulders of the Federal Reserve Board and that a stabilisation of prices at 1928 levels would benefit all interests in U.S.A. and Europe.

J.M.J.

The World Wheat Market; Wheat Prices and.

Vladimir Prokopovich Timoshenko. *Memoir* 118. Cornell University, Agricultural Experiment Station, New York State, U.S.A.

The writer is to be congratulated upon presenting, within the limit of 100 pages, a comprehensive study, by modern statistical methods of correlation, of the major factors determining wheat prices in the representative world market for wheat and also in the markets of some of the leading wheat exporting and wheat importing countries.

Changes in Liverpool prices from spring to fall are closely correlated with Northern Hemisphere production. Prices respond more to the fluctuations of production in the East-European surplus area and in the West-European deficiency area than to the North American production. Berlin and Paris prices of wheat show the same tendency.

Fluctuations of wheat production in different areas show very little correlation and this, in a certain measure, stabilises the prices. But the fluctuations of European production had the greatest influence on prices.

Changes in price from fall to winter and from fall to spring on the Liverpool market respond less regularly to the fluctuations in wheat production in the Southern Hemisphere than changes in price from spring to fall respond to Northern Hemisphere production, and although Southern Hemisphere production is the major factor influencing changes in prices from fall to spring other factors intervene.

Imports of wheat into Europe respond more to production in the European deficiency area than to the crop in the surplus area. European imports of wheat are fairly closely correlated with production in the East-European surplus area but only slightly correlated with North and South American production.

Liverpool prices are more closely related to the amount of wheat directly at the disposal of Western Europe (West-European production plus imports) than to the world production.

The difference between the prices on importing and exporting markets, rather than the absolute level of wheat prices on importing markets, determines the amount of international trade in wheat. But the amount of international trade and the prices in importing markets are not primary but secondary factors, determined by crops in surplus and deficiency areas. C.A.S.

THE AGRICULTURAL DEPRESSION.

Report of the Proceedings of the Conference of the Agricultural Economics Society, held at Cambridge, June, 1929.

Agricultural Depression; Some aspects of the.

R. R. ENFIELD.

The paper principally deals with the effect of a change in the price level upon agriculture, and the author asserts that the present crisis in agriculture is due primarily to the fall in prices. It is to fluctuations in prices as a whole that greatest importance must be attached, since those of individual commodities tend to balance one another. The serious effect of a general fall is to cause a maladjustment between costs of production and prices—costs remain disproportionately high. The significance of the " economic lag " increases with the rapidity of the drop, and this was of outstanding importance during 1920 and 1921.

During a period of deflation certain fixed charges, such as mortgage interest, rent and wages, are only adjusted downwards with difficulty. The disparity between nominal and real interest consequent upon changes in the purchasing power of the monetary unit has been a continually increasing burden to borrowing farmers. Heavy debts are amongst the causes of depression in British agriculture at the present time. It is pointed out that the economic friction within the industry results in maladjustment for an indefinite time; the price of commodities sold in free, " unsheltered " markets respond quickly, whilst in semi and completely sheltered industries considerable resistance is offered. Therefore, there arises a marked dissimilarity between cost of living and unsheltered prices. In agriculture it is most pronounced in the change in the level of prices and wages, and this phenomenon may have to be faced as a permanent factor in British agriculture. Mr. Enfield maintains that the available facts seem to indicate that monetary factors are lively to continue their present influence upon prices.

The paper deals with the principal causes of prices fluctuations and indicates to what extent agriculturists can effect remedies. W.H.J.

Farming Conditions; The Incidence of Notices to Quit and Rent Reductions as an indication of.

D. Skilbeck and M. Messer.

The investigators summarise in this report the results of an enquiry, covering some five million acres, which was carried out in 1928. The results are of two kinds, quantitative or statistical and qualitative or descriptive. Four graphs are included; the first shows a very high positive correlation between notices to quit and reductions of rent with no significant variation from one size group to another in the percentage of the total so affected. The second indicates that notices to quit and rent reductions were far more frequent on the largest than on the smaller farms. From the third and fourth it is clear that, as the proportion of arable land increased, notices to quit and rent reductions become more general.

On the qualitative side an attempt is made to consider the influence of topographical factors (soil types and geological formation, rainfall and climatic conditions) and economic factors (locality, size of farm, type of organisation and system) upon the prosperity of farming. On the chalk formations financial distress is common, but it is primarily due to the fact that the nature of the soil limits variations in farming practice. The areas of heavy clay are also in a depressed condition, but more especially those in the eastern half of England. It is also asserted that the light sand land farmers are suffering, but in this case the artificial stimulus given to the sugar beet industry afforded some measure of relief. It is the large and employing farmers that suffer the greatest hardships; small holders, dairy farmers and those in close proximity to retail markets are in a more fortunate position.

The report brings out two points of importance, viz., that stable conditions obtain in many districts and that in others, manifestly suffering from adversity, individual cases of success occur. W.H.J.

Farming Efficiency and the Agricultural Depression.

A. W. Ashby and J. Llefelys Davies.

This study is particularly instructive in that a factor uncommonly elusive has been reduced to terms amenable to statistical measurement. The productive efficiency of persons engaged in farming in 1871 is compared with that of subsequent dates. Three factors affecting efficiency during that period are submitted, viz., increase in the task, decrease in the time worked and the increase in efficiency per hour of work. It transpires that, on the average, the total task per person as measured by land and stock managing capacity per person increased 30-31 per cent. between 1871 and 1921. Over the same period the hours worked by each person per annum decreased in the ratio of 100 to 89. There was a slight increase in the task per person between 1921 and 1924, but afterwards it has remained about constant. Hours of labour also increased during the former period, but this was not maintained after 1924. Organisational efficiency, however, rose 3 per cent between 1921 and 1924, and 5 per cent. between 1924 and 1928.

The total increase in efficiency between 1871 and 1928 amounted to 54 per cent.; 11 per cent. of this has been taken by the workers in the form of shorter hours, while the task per person has increased by 37 per cent. Two questions of supreme importance arise from the study; not only to what extent have farmers benefited from the increase in efficiency in the past, but how are they to retain some of the advantages that will accrue from increase in the future?

This paper is a clear and concise statement on an extremely complicated subject. W.H.J.

Foreign Competition in Relation to Agricultural Produce; Some Aspects of.

J. P. MAXTON.

In this paper Mr. Maxton endeavours to dispel some current, but erroneous, theories regarding imports of agricultural produce to this country, but more especially to the operation of dumping. It is sometimes implied that an exporting country can maintain prices at home and sell below cost of production abroad. The author points out, however, that under private enterprise, when a country exports produce which is sold at the world price, the home price must drop to that level, even when a country is protected. It is also shown that State bounty on exports is not in operation in countries from which this country draws its main supplies. The system of equalisation of loss, owing to the necessity of selling at the world price, below a fixed home price, is limited to a few cases of minor importance.

Statistics are included to show the extent to which certain countries supply the United Kingdom with agricultural produce; these indicate that the bulk of the more important products are derived from a few more or less specialised countries. Such countries endeavour to study the requirements of the British market, and the goods are generally of high quality. Attention is drawn to the fact that, as a rule, English imports are comprised of the best grades of produce and in many cases imports are low from countries supplying only inferior articles.

The paper is an illuminating introduction to one of our most important agricultural problems. W.H.J.

The Agricultural Depression; Some Human and Social Factors in.

A. W. ASHBY.

An agricultural depression presents several phases, many of which have hitherto received but little attention in this country. In this paper, however, Professor Ashby outlines problems of fundamental importance to the industry. The human attitude towards farming as a business is in many respects unique; the influence of custom and tradition upon the outlook of the people modifies in many ways their response to changing conditions. It is not correct to assume that farmers always seek the greatest financial advantage; indeed, they are not always free to do so, as peculiar social checks are in some districts exceedingly potent. However, small farmers seek positive advantages of a definite nature, such as a status, ownership and control of some capital, a form of economic security and independence. The author advances a reason why small holders maintain their position better than farmers in face of depression.

It is partly due to the fact that but a small amount of public consumption goods enter into the standard of living of small farmers; thus private consumption is reduced easier and their capital does not decrease so quickly. It is suggested that the country population needs to satisfy a greater number of wants, and when more of the pleasures of consumption are appreciated agricultural production will become more efficient.

Migration from agriculture does not leave the country population as a true section of the total population but something of a residuum, *i.e.*, with a high proportion of aged people and minors. The intelligence and general mental condition of country children and also the effect of a depression upon the mentality of the farmer are also important.

This is a most interesting paper, and further work along these lines would undoubtedly be desirable, as the poverty of definite information upon many of these problems in this country is appalling. W.H.J.

The Present Agricultural Depression; Some Impressions of the Nature and Extent of.

R. J. Thompson, C.B., O.B.E.

The author defines an agricultural depression as a condition of affairs where income, as compared with expenditure, is insufficient to provide interest on capital invested and to leave a moderate reward for the farmers' management whilst a more severe degree would be a condition where there is a definite loss of capital, and no reward for management. Index numbers of prices are included to show the two periods of falling prices: from 1920 to 1923 and from 1926 onwards. The index number of all agricultural produce (calendar year) shows a drop of twelve points (7½ per cent.) between 1925 and 1928, but the " all commodities " figure shows a bigger decline; the author maintains therefore that agriculture in the broad sense, has not experienced a greater decline in values than has occurred on the average in the prices of all commodities. Limiting his treatise to the last three and a half or four years, Mr. Thompson maintains that agriculture is suffering from a continuous downward tendency in most prices, but the production of sheep, milk, fruit and vegetables ought to have been fairly profitable, whereas cereal growers and breeders of cattle have had little relief in prices.

On the cost of production side, the author indicates that the price of feeding stuffs, fertilisers and seeds have on the whole been on a lower basis than the prices of agricultural produce. Dealing with the cost of agricultural labour, it is asserted that the index number commonly used does not truly portray the situation as the base figures in 1914 covered all time worked, apart from harvest earnings, whilst since 1924 it refers to a cash wage for a fixed number of hours and thus excludes overtime payments. As an item in cost farmers have had some balance of advantage from the absence of severe fluctuations in rents, but interest on mortgage is a heavy burden on many owner-occupiers.

As regards the geographical extent of the depression, the author claims that it is most pronounced in the eastern half of England—the area being estimated at four and a half or five million acres. It is chiefly noticeable on holdings with a large proportion of land under the plough. The proportion of the agricultural area of England and Wales, so affected would be 17 per cent. at the maximum. Mr. Thompson points to two tendencies in agricultural employment during the depression; since 1924 a 25 per cent. decline in the number of casual workers and an 8 per cent. decline in regular workers has occurred. Men tend to leave agriculture for insurable occupations, whilst fewer enter the industry; however, during the present depression the agricultural worker has not shared the losses experienced by the farmer and landowner. The number of bankruptcies in 1927 was 487 and 465 in 1928, compared with an average of 401 per annum since 1921 and 322 during pre-war years. W.H.J.

MARKETING FARM PRODUCTS.

Beef Production; Can British Farmers Compete—with Imports from Abroad in.

SIR WILLIAM HALDANE. *Journal of the Farmers' Club*, No. 6, 1928.

Food and the Farmer.

Sir WILLIAM HALDANE. Reprint from *The Times*, April 8th, 1929.

These two contributions constitute a useful survey of the position and prospects for beef production in this country. The post-war depression in the cattle trade is largely due to the pressure of imports of uniform and rising quality on the general consuming market for beef. About 40 per cent. of our beef consumption comes from the Argentine, and future prices depend largely on the extent, quality and prices of future Argentine supplies. This latter country may have reached its highest point in beef output. The " meat war " resulted in heavier slaughter and higher prices in the Argentine, and losses sustained by the meat combines had the effect of a subsidy on supplies until the drastic competition came to its end. The presence of endemic Foot and Mouth Disease and the more drastic steps now taken to eradicate it, together with greater care in the inspection of export carcases, all tend towards reduction in Argentine beef exports. A serious fall in the cattle population of the United States of America in recent years may render that country a buyer on the Argentine market in the near future. Higher prices in the Argentine, the cessation of the meat war, and shorter Argentine supplies on British markets offer better prospects for British producers. The position of the latter can be improved by better breeding and rearing of calves and selling beef animals at a younger age.

The greatest gain would result from the grading and orderly marketing of cattle and cattle products, as this is where the imported article has the greatest pull over home produced beef. Centralised selling and uniformity of grades simplify the retailers' problem of buying and selling. Refrigeration should be used to prevent autumn gluts of grass fed beef.

Improved marketing offers the most complete, surest, and most permanent solution of the problems of the cattle industry as well as the greater problems of profitable tillage. T.L.

Cheese in London; The Demand for.

Empire Marketing Board Report No. 22, November, 1929.

In order to obtain the material for this report 500 establishments selling cheese in London were visited and two metropolitan areas were examined in detail. The shops are classified by districts and form of ownership, and this treatment shows quite clearly how the demand for cheese varies by districts. While white imported Cheddar captures the main share of the trade, there is a steady and select market for Cheshire. The survey offers some evidence on retail prices, and the margins between qualities and districts are worthy of closer study. The latter part of the report deals with less important kinds of cheese. The broad conclusions arising from the section on processed cheese are that the carton form of selling is rapidly developing, that it is regarded with favour by buyer and trader and that it is stimulating the demand for cheese. J.M.J.

Co-operative Marketing in Scottish Agriculture; Recent Developments in.

T. G. HENDERSON. Agricultural Economics Society.

This is a concise review of the machinery for organising agricultural co-operation in Scotland and of the activities of societies in 1927. Much of the paper is naturally devoted to the bigger enterprises in Scottish co-operation—such as the Wool Growers and Milk Agency. Recent experience shows the value of an active Organisation Society, the necessity of setting up societies on a regional basis, the advantages of a supply contract, and the beneficial results derived from paying sufficiently high salaries to secure staffs which can serve the business efficiently.

J.M.J.

Co-operative Marketing of Livestock in the United States by Terminal Associations.

C. G. RANDELL. *U.S.D.A. Technical Bulletin* No. 57, 1928.

There are two types of co-operative livestock marketing associations in the United States. The local shipping association and the terminal co-operative commission association. This Bulletin deals mainly with the latter type. These terminal associations provide local shipping associations or individual farmers with the same services as would be given were they to sell through private commission agents on the central markets. The fundamental difference between a terminal association and a commission salesman is that the former's selling charges are based on the actual costs of marketing whereas the latter's commission is fixed and may or may not bear a close relation to actual cost to the salesman. The actual selling commission charged by the terminal associations is usually the same as that charged by commission agents, but members benefit either through a better terminal service or through the distribution of profits.

This Bulletin deals with the causes which gave rise to the establishment of co-operative commission associations and the history of their development. The operations of commission agencies and the services which they perform are described. Management problems are discussed in some detail. In the U.S.A. various farmers' movements have been responsible for the innovation of new marketing organisations. The Farmers' Educational and Co-operative Union of America has been responsible for the establishment of a number of terminal livestock agencies since 1917 and these are dealt with as a distinct group. Another group of similar agencies has been established by the American Farm Bureau Federation since 1920. Other agencies have been promoted independently of the former groups. Each agency is described and discussed separately and a large volume of statistical information is provided relating to separate organisations and groups. The accomplishments of terminal agencies in making cash savings, supplying improved services, in price making, and in the provision of special facilities and educational work are enumerated. Finally a work programme for terminal livestock commission associations is submitted, The Bulletin provides a mass of valuable information relating to a secondary phase in co-operative livestock marketing developments in the United States, and should prove of particular value to all those interested in improved livestock marketing. T.L.

Country Plants in New York; An Economic Study of the Collection of Milk at.

LELAND SPENCER. *Cornell Bulletin* No. 486.

After drawing attention to the influence of better roads, more motors and the enlarged demand for milk on the problem of assembling supplies, the writer examines the factors which determine costs. The application of detailed costings methods to find the effect of distance, method of haulage, size of load and type of vehicle has yielded valuable results. For example, haulage by individual producers is generally more costly when done by horses than motors, especially for longer distances. Commercial haulage is cheaper than individual collection, and the " hundredweight mile " costs are lower for motor than horse vehicles.

The report proceeds to examine the distribution of milk plants from the standpoint of costs of collection, treatment in depots and dispatch. Quite a proportion of farmers are not sending to the nearest plant; the reduction of the number of plants from thirty-one to fourteen in five counties would yield a saving of six cents per 100 lb. milk in handling and shipping costs. It is estimated that only half the plants in the State are really necessary. J.M.J.

Dairy Produce; Fourth Report—Imperial Economic Committee.

Cmd., 2725, 1926.

Butter and cheese are principally dealt with in this report. It may be said that the production of butter and cheese in this country is only about one-sixth of total consumption; that the Empire has come to supply more butter than foreign countries, but that foreign countries are now recovering their position and will in the near future compete again more keenly; that the cheese requirements are met to the extent of over 90 per cent. of the consumption from Empire sources (Home 31 per cent., Overseas Empire 60 per cent.). Of the margarine consumed 70 per cent. is the product of factories in the United Kingdom and 29 per cent. imported from foreign sources.

Whilst it is acknowledged that the marketing and preparing for market of Empire dairy produce has greatly improved of recent years, the main conclusion reached is that it will not be practicable to maintain the present standards of living amongst those dependent on the dairy industry at Home and in the Dominions unless the farming interests, without loss of time, prepare to meet such cutting of prices as may come from increased competition by the adoption of more efficient and cheaper methods of production.

It is pointed out that the quantity of milk and butterfat each cow and each acre can be greatly increased. Cow testing both for quantity and quality of milk should be generally applied throughout the Empire. Improvements in breeding and of pastures and fodder crops should result in a greatly increased output without any great increase in cost.

Denmark has, by means of winter dairying, succeeded in regularising her exports to the United Kingdom so that the quantities received each month vary but little with the season.

Increased winter dairying is strongly urged throughout the Empire where winter conditions prevail.

Retailers are blamed by many observers for an undue lag of retail prices when wholesale prices are falling. A quicker response, especially at the end of the year, when wholesale prices are falling, owing to the arrival of stocks from Overseas, should result in a definite increase in consumption at that period. Wholesale prices would be steadied and there would be a lessening of the opportunity for speculation with steadier returns to the Overseas producer. C.A.S.

Fish; Firth Report; Imperial Economic Committee.
Cmd., 2934, 1927.

The annual value, at the ports, of the fish brought to shore by the fishing industries of Great Britain and the Dominions is computed to be about £34 millions. Of this sum about £31 millions is the value of fish caught in the North Atlantic and North Pacific by Empire fishermen operating from the British Isles, Canada and Newfoundland. The total value of fish brought into the United Kingdom in 1925 was £30 millions, of which British catching amounted to £19¼ millions and £3 millions from other parts of the Empire. Of the total imports of over £9 millions, over £5 millions represented canned fish.

There is considerable support for the widely held opinion that the retail prices of fish have not, in the past few years, fallen comparably with those of other articles of food. This belief seems to be fully supported by the tables published by the Ministry of Labour showing the average percentage increase on July 1, 1927, as compared with July, 1914: Beef (British) 68; Butter (fresh) 48; Bread 69; Eggs (fresh) 34; Fish 111. But notwithstanding this disparity the *per capita* consumption of fish is, as a whole, maintained. There is an increasing demand for white fish and a lessening demand for herrings. The trade in herrings seems to be faced with a definite loss of markets both in the United Kingdom and abroad, and it is urged that new methods of curing be studied and adopted. The necessity for organised research with a view to improving the methods of preserving fish from the moment when it has been caught to the moment when it reaches the consumer is the principal recommendation. C.A.S.

Fruit and Vegetables; Canning of.
Council of Agriculture for England. Report of Standing Committee.

This document deals with the prospects and problems of what may prove to be an important aspect of the agricultural industry in this country. The canning of fruit and vegetables is advocated as a means of absorbing temporary surpluses arising from existing acreages and of providing a market for produce from extended areas. In reviewing the position of the import trade, it is made clear that a good deal of the canned fruit and almost all the preserved vegetables now imported could be raised in this country. Many of the thirty canneries now operating are new businesses, and are not supplied with the requisite raw materials as regards either quality or quantity. They are also faced with the further problems such as high cost of produce, machinery, and scarcity of skilled labour in canneries. The latter part of the report gives detailed information on canning some fruits and vegetables. The Committee feels confident that with the development of research and closer co-operation between growers and canners the young industry will flourish, and that it deserves the active support of the State and the N.F.U. J.M.J.

Fruit for Market; The Preparation of. Part I. Apples, Pears, Plums and Strawberries.

Economic Series, No. 21. Ministry of Agriculture.

Following an earlier general report on fruit marketing, this volume describes the best commercial methods of handling the four principal fruits produced in this country. The first part of the introductory section states the general points which must be regarded in the production and handling so that fresh, uniformly graded, and attractively packed fruit can be placed on the market. In this connection a special section is devoted to packing and pooling stations.

The second part of the introductory section discusses the Agricultural Produce (Grading and Marking) Act in relation to the fruits treated in the report. Details of the scheme now adopted for apples and pears are given.

The main part of the report is a detailed study of the practices which must be adopted if the marketing of graded goods on the lines envisaged in the National Mark scheme is to succeed. For each class of fruit the subjects dealt with in the general introduction are treated in detail. This practical manual of ninety pages is well illustrated with instructive photographs and diagrams. J.M.J.

Fruit; Supplies and Marketing. Third Report—Imperial Economic Committee.

Cmd., 2658, 1926.

A comprehensive report dealing with the sources of supply and marketing of the various fruits; fresh, bottled, dried, canned, etc., imported into the United Kingdom.

The value of total fruit imports into the United Kingdom in 1924 was £48,300,000, and of this sum £38,500,000, or 80 per cent., was paid to countries outside the Empire. During the five year period ended 1904, 11 per cent. of the imported fruit supplies were obtained from countries within the Empire. For the five years ended 1913, 18 per cent. were so obtained. In 1923 the percentage had reached 20 and in 1924 it has risen to 21 per cent. of total fruit importation.

It is the considered opinion of the Committee that the bulk of our fruit requirements, so far as supplied from overseas, excluding grapes and oranges for winter consumption, might be met from within the Empire. The fresh fruits most extensively eaten in this country are apples, oranges and bananas. Every person, on an average, consumed in 1924 about 100 apples, 70 oranges and 30 bananas. Of the 100 apples eaten 38 were supplied by the United States, 25 were home grown, 19 imported from Canada and 8 from Australia and New Zealand. Of the 70 oranges 57 were supplied by Spain, 7 by Palestine, 3 by South Africa and 1 by the United States. Of the bananas 16 were derived from Central America, 7 from the Canary Islands and 5 from Jamaica.

In regard to each of these fruits there is a foreign country whose supply dominates the United Kingdom market. In the case of apples the vast American crop has an influence on the home market out of all proportion to the quantities sent. An organisation under American control monopolizes the whole supply of bananas from Central America and Jamaica to the United Kingdom to the extent of 23 out of 30 bananas consumed per head of the 1924 population. This corporation—the United States Fruit Company—ships and markets its bananas to the United

Kingdom through Messrs. Elders and Fyffes, a company registered in this country but with 99 per cent. of its shares held in the United States; 88 per cent. of these shares are held by the United Fruit Company.

Emphasis is given to the necessity for much higher efficiency both in production and in marketing, but it is pointed out that the best that can be done in this direction is liable to be brought to nought by the wrecking influence of the United States surplus which is exported to prevent any serious break of prices in their home market. To the Dominions, however, the market of this country is the primary and often the only available market outside a limited home market. The 274 pages of this report are full of valuable information to the student of Empire economics. C.A.S.

Markets and Fairs in England and Wales; Eastern and Southern Markets. *Economic Series* No. 28. Ministry of Agriculture.

This well illustrated report is the fourth of a series which is designed to furnish a useful guide to all concerned with the primary markets for farm products in England and Wales. The markets are classified according to ownership, to type, and according to the class of farm produce sold. Some general notes are made on the agriculture of each county and detailed descriptions are given for selected markets. The mass of detail in the report apart from its local interest, is extremely valuable since it indicates the close connection between topography, farming conditions, transport facilities and the size and distribution of markets. It also offers a basis for estimating the efficiency of the present system of primary collection and sale of produce and of individual markets. The text and the valuable appendices embody facts the collection of which is an important step in demonstrating the principles underlying efficient distribution and in building up a more rational system of farm marketing.

J.M.J.

Ohio Farmers' Elevators; Economic Aspects of. L. C. Foster. Agricultural Experiment Station, Ohio, *Bulletin* No. 416.

This study, which covers the year 1924, deals with the development of farmers' elevators in Ohio and discusses some of the more important problems of management which the elevator has to meet.

All elevators in Ohio handled fertilisers and feeding stuffs whilst the majority handled many other farmers' requisites. Indeed these sales formed an integral part of the elevator business and appeared to be increasing in all parts of the State. In more than 50 per cent. of the companies' businesses merchandise was responsible for more than half of the total sales, and in the elevators in which the grain business predominated merchandise accounted for from 10 to 40 per cent. of total sales.

The fact that 202 farmers' elevators out of 265 had a membership of 32,764 producers represents the extent to which the movement has developed. It is estimated that more than 42,000 farmers are directly interested in the elevator business of the State.

The average operating capital requirement of 165 grain and merchandise elevators was $23,418, or about 50 per cent. of the total capital requirement. The most common amount subscribed by farmers at the beginning of the operations was $16,000. The balance of the capital was raised by loans from the banks and individuals.

The principal causes of failures of farmers' elevators were incompetent management, lack of adequate capital and the starting of companies where they served no economic purpose. A majority of farmers' elevators were lax in their methods of grading and docking, which in many cases led to severe losses to their companies. Practically every producers' elevator had one or more local independent competitors for grain and merchandise at its local shipping point. Competition for the surplus grain of the Ohio farms was keen. The 265 producers' elevators, 848 private elevators and 420 flour mills furnished ample facilities for handling the surplus. Storing grain for farmers was practiced by 65 out of the 198 elevators for which data was secured. Brokers and track buyers obtained the bulk of the grain moved out of the State. Most of the sales were made " on track " or " to arrive ".

Dealing in farmers requisites is becoming more important in all Ohio elevators and is complicating the problem of management and finance. C.A.S.

Pigs and Pig Products; Twelfth Report—Imperial Economic Committee. 1929.

The importance to the Empire of the trade in bacon, ham and pork cannot be measured in terms of money only. Pig-keeping plays, or should play, an important part in closer settlement. The general rule is for pig keeping to be associated with some other type of farming. An extensive trade in pig products can be based on the activities of a large number of small-holdings. In Denmark about one-third of the pigs are reared on farms of less than 37 acres and nearly seven-eights on farms of less than 150 acres.

In exercising his preference for Empire bacon or hams the British consumer is either aiding the farmer in his own country or assisting the development overseas of compact communities which will afford outlets for British manufacturers.

Producers in certain European countries have, through efficiency of production, attained a strongly entrenched position in the market of the United Kingdom. Increasing efficiency in production and marketing on the part of the Empire producer will be met by a redoubling of effort on the part of those who have already such a strong footing in the market of this country.

The total annual value of pig products consumed in Great Britain and Northern Ireland is not less than £95 millions; of this total some £55 millions worth are imported, and only about £8 millions of these imports are of Empire origin. The Empire farmer at home and overseas can, if he will, secure the greater part of the British market, but if he desires to do so he must make his production at least as efficient as that of his most competent foreign rival and must bestow at least equal attention to organisation. Organisation falls into two parts; firstly, the association of farmers with farmers, and secondly the co-operation of the curers with the farmers.

Close co-operation between farmers is essential. A standard type of pig must be produced and in sufficient quantities to admit of economic handling by modern commercial methods. A breeding policy must be based upon market requirements, not pedigree and show points. Many breeding and show points have absolutely no commercial significance, and it is earnestly recommended to those responsible for the pig classes at agricultural shows throughout the Empire that awards should be made on the commercial merits of the stock. Attention is drawn to the system in Denmark whereby in addition to purity of breed, a record of commercial importance is also needed before a pig can be entered in the Herd Book.

It is recommended that research into problems of nutrition be directed towards three ends—the production of a uniform standardised pig under farm conditions, the most economic use of food products of the farm, and the reduction of disease. C.A.S.

Poultry and Eggs; Sixth Report—Imperial Economic Committee.

Notwithstanding the fact that the United Kingdom produces nearly half the eggs which it consumes, £19 millions was spent in 1925 on imported eggs and £2½ millions on imported poultry from all sources. These payments represent one-fifth of the expenditure in that year on imported meat and one-third of that on all imported dairy produce. Both in 1925 and 1926 the import trade in poultry products into the United Kingdom surpassed in value that of all the exports of motor cars motor cycles, cycles and rubber tyres.

Excluding the Irish Free State, which supplies about 20 per cent. of the imports of eggs and 31 per cent. of poultry, the rest of the Empire's share in this market is very small—about 3 per cent. of imported eggs and 2 per cent. of table poultry.

In all the Dominions strict control under legislation ensures a high standard of quality and of uniformity in the size and weight of eggs exported. This is also true of Northern Ireland in respect of the wholesale trade. The bulk of the eggs and poultry produced in Great Britain is marketed ungraded and poorly packed and there is pressing need for the acceptance and observance of generally recognised standards in both these respects.

Economic standardisation of prevalent types of poultry has been established throughout large areas in other lands and this standardisation is recommended for Great Britain. Multiplicity of grades and standards should be avoided.

The definite conclusion to be arrived at is that the poultry industries of the Empire are capable of considerable profitable development, but such development can only be secured by the wide application of accepted grades and standards. Unless marketing is organised on modern commercial lines much of the benefit derived from improvements in poultry breeding and management will be lost. Co-ordination of the results of scientific and economic work on poultry throughout the Empire is recommended. C.A.S.

Shipping Ohio Livestock; Losses in.

Geo. F. Henning. *Ohio Agricultural Experiment Station Bulletin* 438, 1929.

This study is the result of an investigation into the incidence of casualties and losses involved in the transit of livestock from country stations into the Cleveland Stock Yards from October, 1926, to September, 1927. The volume of arrivals at the Stock Yards consisted of 18,701 car loads. The total number of livestock delivered by rail and road trucks amounted to nearly 1½ million head.

As the inspections were carried out at the delivery end little could be done to elicit the causes of losses which occurred in transit previous to arrival at the yards. The influences of different classes of conveyances, length of journeys, temperature and methods of loading are shown. The information contained in this publication can have little application under the widely different conditions in this country, but the methods of analysis and presentation should be studied by anyone projecting a similar investigation. T.L.

The Marketing of Cattle and Beef in England and Wales.

Economic Series No. 20. Ministry of Agriculture.

This report deals with the more important aspects of the marketing of cattle and beef. The veal trade and the trade in hides and skins are not dealt with as these will be the subjects of separate reports.

The report is comprehensive in its scope, embracing the nature and extent of supplies from various sources; the characteristics of production and demand on the home market; prices; methods of assembling; grading and transportation; methods of sale and the processing of cattle; the organisation of the wholesale and retail meat trade and the utilisation of offals and by-products. The report concludes with a statistical section relating to various aspects of the trade and three brief appendices dealing with the organisation of the cattle and beef trades in the U.S.A.

The whole cattle industry is the most important branch of English agriculture and beef output is second only to liquid milk in importance. The home production of beef has declined from 70 per cent. of the total supplies a generation ago to less than 50 per cent. at the present time. The increase in the cattle population during the last sixty years has not kept pace with the growth of the human population. The increase in liquid milk production has tended to decrease the beef output and to introduce changes in the quality of the home beef supplies which have tended to depress average prices.

The success of imported beef has been due to low production costs, close adaptation of supplies to the English market requirements and a system of central slaughtering adopted in the chief exporting countries. Home producers may not be able to compete with foreign supplies in price but they can compete in quality. Home producers can maintain their position on the market by improving their methods of production and marketing. In the interests of all concerned a grading and marketing scheme for the better qualities of home killed beef would seem desirable; the abandonment of small scale slaughtering and the extension of efficient large scale slaughtering appears desirable and inevitable. There are considerations and suggestions of some possibilities of improvements in the marketing of store and fat cattle as such in order to meet changing conditions of slaughter and distribution. T.L.

The Marketing of Milk; Incidence of Production in Relation to.

A. E. Magee. *Journal of Farmers' Club*, Part 3, 1929.

After citing evidence of the difficulties of fixing prices for liquid milk in England and Wales, Mr. Magee proceeds to state and elaborate on the general problem. He regards ignorance of demand and inability to control supplies as the vulnerable points in the producer's position. This has arisen from the lack of contact between producer and consumer due to the growth of cities and transport, and an analysis of the position reveals how the wholesalers controlling surplus have secured control of the liquid market. It is emphasised that prices cannot be controlled without controlling supplies and surplus. Proceeding to sketch the history and principles of the Scottish Milk Agency, Mr. Magee maintains that its foundation principle is that no milk is allowed to reach the distributor except at liquid prices. The Agency is making efforts to improve the conversion value of milk and to foster the consumption of liquid milk. J.M.J.

Timber; Tenth Report—Imperial Economic Committee.
Cmd., 8175, 1928.

The imports into the United Kingdom in 1927 of timber, manufactured wood and wood pulp were valued at £67 millions. Importation of timber alone came to £50 millions, of which some 90 per cent. was derived from foreign sources. Among the many raw materials imported into the United Kingdom this high figure was only surpassed by wool and cotton.

A careful census of the production of " home-grown " timber in 1924 placed a value of £2,036,000 upon the fifty-six million cubic feet felled (not sawn or converted). The annual consumption of standing timber in Great Britain and Northern Ireland is estimated at about 1,100 million cubic feet, of which approximately 90 per cent. are conifers, or softwoods, and under 10 per cent. are hardwoods. Home-grown timber constitutes 3 per cent. of the supply of softwoods and about one-quarter of the supply of hardwoods. The fall in declared values of imported timbers between 1924 and 1927 was 12.2 per cent. In the same period prices of iron and steel fell by 16.1 per cent. The value of timber imported for the year 1926 was, in round figures: Empire sources £4 millions; Foreign sources £35 millions.

The adequacy of the world resources of timber, especially softwoods, to meet the world consumption of the future is causing grave anxiety to forestry authorities, but this apprehension does not appear to be shared by members of the timber trade in the United Kingdom.

The forestry resources of the United Kingdom have for long been inadequate to meet the needs of the country. It is estimated that some 450,000 acres, mainly of softwoods, were " clear-felled " during or immediately after the war, yielding about 1,000 million cubic feet of timber. This represented about one-third of the timber resources of Great Britain. Naturally the best and most readily accessible timber was taken. At the present time it is probable that fellings exceed planting.

To secure a wider use in the United Kingdom of Empire-grown timber there must be a supply, regular and sufficient in quantity, suitable in quality and competitive in price, and backed by adequate propaganda. C.A.S.

Tobacco; Ninth Report—Imperial Economic Committee.
Cmd., 3168, 1928.

A rapid increase in world consumption of tobacco has taken place during the last twenty years. In the United Kingdom the average consumption has risen from 2.4 lbs. a head of population in 1914 to 3.4 lbs. a head in 1927. This consumption is still smaller than in Belgium, Germany and the United States. Any further increase in this country is not anticipated.

For the year 1926 total world production was estimated at 4,900 million lbs. and of this total the United States account for 26.5 per cent. whilst the British Empire figures are 22.1 per cent.

In the international trade in tobacco the Empire occupies a minor place, her contribution being in 1925 only about 4 per cent. The United States provided 39 per cent. of the total, the Dutch East Indies and the Balkans each 16 per cent. and Brazil 6 per cent. Partly as the result of the Customs preference granted to Empire tobacco in the United Kingdom, the proportion of Empire imports has risen from 8 per cent. of the total imported in 1921 to 18 per cent. in 1927. Some 80 per cent. of total imports into this country are still drawn from the United States.

It is clearly not in the interest of the retailers to push Empire tobacco as against the more highly priced American, for the margin of profit on the latter retailing at 11d. an ounce is appreciably greater than an Empire product at 7½d. an ounce.

The Empire now sends to Great Britain some 37 per cent. of pipe tobacco smoked there, but only 1 per cent. of its cigarette tobacco. The production of cigarette tobacco, therefore, offers the greatest opportunity to Empire producers for the home market, especially in view of the assertion that the people of the United Kingdom are the greatest cigarette smokers in the world.

The institution of a Tobacco Information Committee for the purpose of keeping the trade in touch with various aspects of production and marketing, both within and without the Empire, is recommended, whilst attention is directed to the necessity of more research as regards suitable types of tobacco plant, ageing and maturing, aroma, etc. C.A.S.

Wheat, Barley and Oats in England and Wales; Report on the Marketing of.

Economic Series No. 18, Ministry of Agriculture and Fisheries, 1928.

A detailed investigation into the marketing of wheat, barley and oats and covering all phases of a very difficult subject is contained within the 206 pages of this report.

Amongst the more important facts to which attention is drawn is the tendency for the manufacturers of cereal products of all kinds in this country to become concentrated into larger units but without any compensating movement amongst the large number of comparatively small producers to establish selling organisations. The result is that the producers have no bargaining power. Organisation of producers is also necessary to ensure more even marketing to prevent the seasonal price depression which occurs in the early months of each cereal year. Taking one year with another native wheat sold from January onwards may be expected to make £1 per ton more than the same wheat sold just after harvest.

The absence of any standardisation or grading of home-grown cereals places producers under the greatest disadvantage, and various avenues are explored and suggestions advanced to remedy this powerful hindrance to realisation of better prices.

The absence of any legal standard regarding the quality of bread is discussed. It is pointed out that while the water content of milk, butter, tobacco and other products is definitely limited by law there is no statutory limit set to the amount of water used in bread-making. Every advantage is no doubt taken of this omission. The yield of loaves per sack of flour is still the paramount factor in commercial baking. If one sack of flour yields more loaves than another the difference is due to the extra water retained. It is suggested that a statutory limit of the percentage of water in white bread to 35 per cent., and in brown bread to 40 per cent., would materially improve the quality, palatability and nutritive value of the bread sold in this country. Incidentally, any move in this direction would have a beneficial reaction on the use of English wheat-flour for bread-making, since the present extent of its use for this purpose tends to be limited by the fact that English wheat-flour is not the best medium for absorbing and carrying water.

The special problems of barley and oats are fully discussed and the report includes valuable statistical information and appendices, together with many interesting illustrations. C.A.S.

RURAL SOCIOLOGY.

Rural-Urban Sociology; Principles of.

P. Sorokin and C. Zimmerman. New York, 1929.

This closely packed volume of some 650 pages, which is modestly described by its authors as being merely an abbreviated manual and the forerunner of a more fundamental three-volume work to be published in 1930 or 1931, represents a notable and unique contribution to knowledge of rural sociology.

The fundamental task of rural sociology is defined as that of describing and explaining " the relatively constant universal traits or relations of the rural or urban social universe ". The authors have not been content to draw their conclusions from American experiences alone, but have sought to base them on " the existing data of almost all countries ". Nor have they confined themselves to " a mere description of . . . phases of rural life "; the extensive data which they have collected are given not for their own sake, but " in inter-correlations with other social phenomena ", and in such a way as to build up the structure of a scientific rural-urban sociology.

The book falls into five main divisions. Part I is devoted to a definition of the rural and urban worlds, and to a discussion of the position of the farmer-peasant class in the " Great Society ". Part II deals with bodily and vital traits of the rural-urban population, and Part III with rural-urban intelligence, experience and psychological processes. Part IV, entitled " A Cross-Section of Rural Urban Behaviour, Institutions, and Culture ", compares and contrasts rural and urban society in their relation to the family, religion, politics, aesthetics, and other aspects of social life. Part V makes a thorough study of rural migration, and concludes with a discussion of the problems for the future involved in the process of " urbanization ", which is slowly but surely levelling out the differentiation between city and country.

Each of these subjects is treated with scientific thoroughness, and the discussion is supported by a wealth of statistics and references, which in themselves would almost suffice to make the book indispensable to any serious student of rural sociology. In whatever aspects of the subject a reader may be seeking information—for instance, on the cephalic indices of the country and city-dwellers of Italy and Switzerland, on the cancer death-rates of agriculturists as compared with other classes in England and Wales, on the proportion of Roman Catholics in the rural population of the U.S.A., or on the historical record of rural societies in relation to nationalism and Socialism—in this book he is almost certain to find a concise summary of the information required, together with documentary references which will enable him to carry his study further.

The authors give us warning in the Preface that their rural origin is to be " particularly apprehended, as a possible source of pro-rural bias "; and they certainly make no secret of their sympathetic attitude towards the values for which rural society stands, or of their opinion of such urban developments as Bolshevism and Modernism. The whole trend of their argument goes to show that the rural population is at least equal, if not superior, to the urban population in physical qualities, and in mental qualities so far as these can be measured. Nevertheless, they can hardly be charged with a lack of the impartiality which befits a scientific study; the facts and arguments on each side of the question are candidly set forth and examined; and, on the whole, no conclusions are drawn which are not supported by a mass of authoritative evidence. Sometimes, perhaps, they may give the impression of being a little too anxious to " make a case "; for example, when arguing that the political representation of the farmer-peasant class is much below its proportion of the total population, they give statistics of most European countries but omit those of Denmark, which might suggest an opposite conclusion. Still, such an omission may be due to the lack of space, and in any case, the exception is hardly of sufficient importance to affect the general course of the argument.

Apart from minor faults in grammatical (or printer's) errors, *e.g.*, on pages 44, 74, 91, 228, 413 and 549, the book is well arranged and well written, and is obviously the fruit of a prodigious amount of research. It is true that the data is mainly drawn from America and Europe, but this is almost inevitable in view of the scarcity of reliable statistical information concerning the rural and urban societies of Africa and the East. Not only have the writers brought together a body of facts concerning rural sociology such as has never before been gathered together into a single book, but their analysis and interpretation of these facts, and their criticism of the sociological theories which have been based upon some of them, are full of significance. An excellent index adds considerably to the value of the book. D.J.D.

ANIMAL NUTRITION.

Abstractor:

R. O. Davies, M.Sc., University College, Aberystwyth.

Animal Nutrition; Recent Advances in.

W. Godden, Rowett Research Inst., Aberdeen. *Agr. Progress*, 5, 20-31 (1928).

This paper reviews the results of recent research on animal nutrition with particular reference to vitamins and mineral elements.

Calcium Carbonate; The Influence of the addition of—to a Ration Low in Lime on the Appetite and Digestibility of the Food in Swine.

R. E. Evans, *J. Agric. Sci.*, 1929, 19, 799-801.

Animals on a calcium deficient diet suffer periodically from loss of appetite though the ration is in every other respect satisfactory.

The results show no enhanced effect on the digestibility of the organic constituents of the food on adding calcium carbonate to a lime-deficient ration. R.O.D.

Calcium Compounds; The Relative Utilisation of different—by Hens in the production of Eggs.

G. D. Buckner, J. H. Martin and A. M. Peter. *J. Agr. Research*, 36, 263-8 (1928).

A study was made of the comparative effectiveness of calcium carbonate, calcium sulphate, calcium phosphate, calcium chloride and calcium lactate in the production of eggs when fed to hens as supplements to a wheat, corn and skim milk ration. Calcium carbonate was most effective as judged by the degree to which it was utilised in the production of eggs, its influence on the weight of egg contents and shells and the quantity consumed. Calcium sulphate was readily eaten by the hens, but produced fewer and lighter eggs. The lactate was apparently well utilised but the intake was small. Calcium chloride was not voluntarily consumed. Its addition to the basal ration caused only a small increase in egg production. The phosphate serves as a source of calcium, but not as well as the carbonate. R.O.D.

Calcium Metabolism in the Laying Hen. 111 Calcium carbonate and hatchability.

G. D. Buckner, J. H. Martin and A. M. Peter. Kentucky *Agr. Exp. Sta. Bull.*, 291, 1929.

In the absence of a calcium carbonate supplement from the diet of laying hens on a ration consisting of yellow corn, wheat and buttermilk fed with green feeds, the hatchability of fertilized eggs was diminished and the percentage of infertile eggs was increased. Fewer eggs were laid and they became smaller, and smaller chickens resulted.

R.O.D.

Calves; Milk Substitutes in the Rearing of.

Orr, Crickton, Shearer and Speedy. *Scottish J. of Agr.*, 1929, XII, 168-174.

As a result of experiments carried out at different centres it is concluded that the addition of appropriate supplements of protein, minerals and cod liver oil improves an oatmeal and linseed ration fed to young calves. By the use of such a supplement the quantity of milk required to rear a calf indoors during winter can be reduced. In the case of animals on good pasture little effect of the addition of the supplement was noted, the pasture supplying all the constructive material required.

R.O.D.

Cod Liver Oil; Some of the Effects produced on the Richness of Cow's Milk by feeding.

J. Golding. *Proc. 8th World's Dairy Congress*, 1928, 44-9.

The growth promotion property of milk, associated with Vitamin A content, can be increased ten-fold as compared with a basal ration of straw, mangolds and selected concentrates. Its antirachitic properties associated with Vitamin D can also be increased to a marked degree as compared with a similar control ration. The fat content of milk is reduced by feeding more than 4-6 oz. of cod-liver oil per cow per day.

No such fat reduction was produced when the unsaponifiable fraction of cod-liver oil (equivalent to 8 oz. of oil) was fed in soln. in pea nut oil, nor when a commercial preparation of the vitamin fraction of cod-liver oil was fed in the same way. R.O.D.

Composition of Milk; The Influence of Feeding on. Mangels versus Dried Sugar Beet Pulp.

H. T. Cranfield. *J. Agr. Sci.*, 1929, 19, 302-310.

Experiments were carried out at two centres in Leicestershire during the spring of 1928, with the object of comparing the values of mangels and dried sugar beet pulp in the winter ration of dairy cows.

The usual method of feeding for a period on one ration and then reversing was adopted. Although there are indications that the change of ration caused a slight temporary variation in the quality of the milk, the secretion of milk solids followed, in a general way, the variation in yield. R.O.D.

Dried Sugar-Beet Pulp and Molasses-Sugar-Beet Pulp in the Nutrition of Swine.

Woodman, Duckham and French. *J. Agr. Sci.*, 1929, 19, 656-668.

Pigs are able to digest dried sugar-beet pulp and molasses-sugar beet pulp to an extent very little inferior to that to which ruminant animals are able to digest these feeding stuffs. Its bulk, however, prevents its being a suitable food for use in more than small quantities when it is desired to make pigs into bacon as quickly as possible. There seems no reason, however, why sugar beet pulp should not be used in moderate quantities as a food for breeding stock, or for pigs which are not being fed to their maximum appetite with a view to obtaining early maturity. R.O.D.

Iodine; Investigations on the Influence of the Feeding of—to Pregnant Sows on the Weight of the Litter and the Development of the Young Pigs.

István Weiser and A. Zaitschek. *Fortschr, Landw.*, 4, 229-230 (1929).

Although the conditions were such that the controls made very good growth, the addition of small amounts of Iodine to the diet resulted in significant increases. R.O.D.

Manganese as a Factor in Hemoglobin Building.

R. W. Titus and H. W. Cave. *Science*, 68, 410 (1928).

Rats and rabbits were kept on an exclusively whole milk diet when the hemoglobin decreased. The addition of 5mg of iron as ferric chloride per day to the diet had but slight effect in the building of hemoglobin as compared with the addition of 5mg. of manganese as manganous chloride, along with the ferric chloride. R.O.D.

Milk; The Effect of the Cow's Ration on the Vitamin A and Vitamin B content of.

W. E. Krauss. *Ohio Agr. Expt. Sta. Bi-monthly Bull.*, 198-201 (1928).

Determinations by the usual animal technic of Vitamins A and B in the milk of cows fed on high protein and low protein rations showed differences too small to be of any practical significance. Apparently a cow can tolerate extreme levels of protein feeding without materially affecting these two factors of the milk. R.O.D.

Milk; The effect of the Cow's Ration on the Food Value of.

W. E. Krauss. *Ohio. Agr. Expt. Sta. Bi-monthly Bull.*, 13, 195-8 (1928).

A complete diet is defined as containing adequate amounts of energy producing substances, protein of good quality, certain minerals such as calcium, phosphorus, iron and also vitamins. Cows do not need Vitamin B in their food inasmuch it can be synthesised in the rumen. Vitamin A potency in milk increases with the richness of the feed in this vitamin. Milk is at best a rather poor source of Vitamin D. For feeding milk cows, a good grain mixture supplemented with some form of well-cured leafy roughage and silage in the winter and with pasture in summer is recommended. R.O.D.

Mineral Content of Pastures. Lime-deficient Areas and a hitherto unsuspected Malnutrition Disease in Sheep.

B. C. Aston. *New Zealand J. Agr.*, 37, 145-51 (1928).

Bone weakness in animals grazed on a certain burned over New Zealand soil of volcanic origin was traced to a deficiency of calcium in the soil. The soils were highly acid, having in some cases a lime requirement of ten tons per acre and the unlimed pastures were characterised by vegetation which thrives on acid soils. R.O.D.

Mineral Supplements; An Experiment in the Free-Choice Feeding of— to Dairy Cattle.

W. B. Nevens. *Ill. Agr. Expt. Sta. Bull.*, 316, 118-24 (1928).

No particular craving or desire for mineral supplements other than for common salt was demonstrated in the dairy cattle kept under the conditions of this experiment. The cattle were kept in barns under ordinary herd conditions, and were fed rations consisting of well cured legume hay, corn silage, and a grain mixture containing protein feeds rich in phosphorus. In addition common salt, finely ground limestone, and bone meal of feeding grade were supplied free-choice. Almost insignificant amounts of the limestone and bone meal were consumed when offered in this manner. Feeding common salt at the rate of 1 per cent. of the grain mixture is insufficient to satisfy the desires of dairy cattle for this compound. When additional salt was supplied in feed boxes, larger amounts were consumed. R.O.D.

Nutritive requirements of Milch Cows in Relation to the Composition of the Milk produced.

Nils Hansson. *Proc. 8th World Dairy Congress*, 1928, 190-7.

Tests carried out over a period of two decades have shown that the quantity of productive food required by milch cows is to a high degree dependent on the composition of the milk produced. The production food required by milch cows may be estimated as 0.30 food unit (defined as the amount of net energy which, with an all round diet, is recovered in the amount of milk produced by 1 kg. of barley or by the quantities of other food stuffs equivalent thereto) per kg. of milk when the fat content of the latter amounts to 2.75 per cent, and to 0.42 food unit when the fat content is 5.0 per cent. Under normal conditions a maximum of 75 per cent. of the digestible albumin contained in the food is to be found in the milk; this figure, however, is dependent on the biological value of the albumin in the food. R.O.D.

Nutritive Value of Milk. 1, Production of Nutritional Anemia in Albino Rats through exclusive whole Milk Diets.

W. E. Krauss. *Ohio J. Dairy Sci.*, 12, 74-9 (1929).

An exclusive whole milk diet fed to weaning rats from normal females produced severe anemia in four-six weeks. The preventive or curative power of different substances can be determined by supplementing the milk diet with them. Substances which give the best results in preventing anemia were a specially prepared yeast, hog liver and solutions of iron and copper fed simultaneously. R.O.D.

Pasture; Nutritive Value of. IV, The Influence of the Intensity of Grazing on the Yield, Composition and Nutritive Value of Pasture Herbage. (Part II).

Woodman, Norman and Bee. *J. Agr. Sci.*, 1929, 19, 236-265.

Under a system of three weekly cuts, pasture grass retains the non-liquified, highly digestible character which it possessed at the end of a week or of a fortnight's growth. Since this characteristic of high digestibility is retained by cutting at three weekly intervals over the whole season, it may be inferred that similar results would follow from a system of rotational grazing, where the pasture enclosures, after being closely grazed, are permitted a three weeks' interval of unchecked growth before being grazed again.

Although the nutritive ratio of the pasture herbage is gradually becoming wider as the system of cutting becomes less severe, the values for the grass obtained by cutting every three weeks were still significantly narrower than that of milk during the early part of the 1928 season and also during July, August and September.

Cutting at fortnightly intervals produced 29.8 per cent. more dry matter over the whole season than was obtained under a system of weekly cuts, whilst the yield obtained by cutting at three weekly intervals was 62.3 per cent. greater than that obtained by weekly cutting and 25.5 per cent. greater than that grown under a fortnightly cutting system. The disparities in productivity were most outstanding at those periods of the season when unfavourable meterological conditions for growth were prevalent. R.O.D.

Phosphorus Deficiency in Forage Feeds of Range Cattle.

S. G. Scott. *J. of Agr. Research*, Vol. 38, 2, 113-130.

Many Montara forage crops, while plentifully supplied with calcium, are deficient in phosphorus. This phosphorus deficiency is found to be physiologically detrimental to cattle. The analysis of the soil samples collected in affected areas show a high calcium content, while the phosphorus content is apparently adequate. Since the forage crops grown on these soils are phosphorus deficient it is to be inferred that the soils phosphorus is for some reason not readily available for plant assimilation. R.O.D.

Protein and Mineral Metabolism in pregnant Sows on a normal or high Calcium diet compared with a Calcium-deficient Diet.

R. E. Evans. *J. Agr. Sci.*, 1929, 19, 752-798.

Results are given which demonstrate that a deficiency of lime in the food has no detrimental effect on the live weight of the young piglings at birth, thus showing that up to parturition it is the mother organism that suffers and not the offspring. The high calcium group of sows retained more nitrogen during pregnancy than the calcium deficient group. The addition of calcium carbonate to the food resulted in an increased retention of ash. It was found that lime economy on a low lime intake is enhanced with the advancement of gestation. It is computed that the calcium deficient sows had to sacrifice at least 100 gm. CaO from their own organism for the calcification of the foetus only. This explains the lack of milk by these sows when they are farrowed. The phosphate retention of the lime deficient animals was not only positive in all cases, but in three periods was higher than any recorded for the normal sows. The results clearly show that phosphate absorption is in no way interfered with by a lack of calcium in the diet. Where lime was deficient, the retention of potash was decreased nearly 50 per cent.

There was an indication of a definite, though not serious anaemia in the lime deficient sows. Slight lymphocytosis was also observed in the animals. R.O.D.

Protein gain in Suckling Pigs; Metabolism Studies on.

WERNER WOHLBIER. *Biochem. Z.*, 202, 29-69 (1928).

Growing suckling pigs excrete progressively increasing amounts of Nitrogen metabolic products so that continually a smaller fraction of the consumed food protein is retained by the growing organism. The reason for this has been found partly in the diminishing protein content of the mother's milk, but more especially in the fact that on the average the same amount of protein per unit of body weight undergoes destruction, and therefore larger quantities of Nitrogen are excreted with increasing weight. This relationship, however, is greatly obscured by individual varieties not easily interpreted, so that the only definite finding is really the coincidence of the maximum protein catabolism and the maximum gain in weight. R.O.D.

Protein Requirements of Dairy Cows.

ISTVÁN WEISER. *Proc. 8th World's Dairy Congress*, 1928, 26-9.

In feeding experiments on ten cows lasting over three consecutive thirty day periods, lowering the digestible protein per day per cow from 3.54 lbs. to 1.92 lbs. while the starch equivalent was increased from 15.2 to 15.7 lbs. had practically no effect on the yield of milk. This was equivalent to a reduction of digestible proteins from .99 lbs. to .44 lbs. per gallon of milk. This reduction was undoubtedly partly compensated by the administration of extra amides present in turnip fodder. The results agree with the minimum requirements stated by A. Buschmann (1.80 lbs. digestible protein for a 1,000 lb. cow producing three gallons) rather than those of O. Kellner (2.30 lbs. digestible protein for 1,000 lb. cow producing three gallons). R.O.D.

Swine; The Value of whole Sugar Beet in the Nutrition of.

WOODHAM, DUCKHAM and FRENCH. *J. Agr. Sci.*, 1929, 19, 669-676.

These experiments were conducted as a result of enquiries as to the value of sugar beet for pigs. It is concluded that whole sugar beet, suitably grated, may be used to replace barley meal up to 25 per cent. of the total ration in the production of bacon pigs. The substitution should be effected at the rate of 3½ lbs. of sugar beet to 1lb. of barley meal. R.O.D.

Vitamin E; Distribution of.

N. Simmonds, J. E. Becker, and E. V. McCollum. *J. Nutrition,* 1, 29-47 (1928).

Certain samples of lard and cod-liver oil promote fertility to an extent which compels the conclusion that they contain considerable amounts of E. The study of the distribution of E is complicated by the considerable variation in the degree to which individual male rats withstand the effects of diets low in E. Some remain potent much longer than others. R.O.D.

Vitamin E; Relation of—to Growth and Vigour.

H. M. Evans. *J. Nutrition,* 1, 28-8 (1928).

Vitamin E is concerned not only with the physiology of reproduction, but also the lack of E in mother's milk entails a peculiar paralytic disease in the suckling young. R.O.D.

Wool Growth of Angora Rabbits; The Influence of certain Foods on.

J. N. Pickard, Univ. Edinburgh. *Scottish J. Agr.,* II, 344-6 (1928).

The addition of a few drops of cod-liver-oil to the daily ration increased the growth of wool on Angora rabbits. The twenty-eight rabbits which acted as control yielded 1,346 g. of wool, while the same number which were also given cod-liver-oil produced 1,506 g. of wool. Addition of mineral mixture decreases the yield of wool as compared with the yields obtained from the control animals and from those receiving cod-liver-oil. The experiments are being continued. R.O.D.

ENTOMOLOGY.

Abstractor: J. R. W. Jenkins, M.Sc., University College, Aberystwyth.

Agricultural Entomology.

Robinson and Jary. Cr. 8vo., XI + 314 pp., 149 figs. London: Duckworth, 1929. Price 15s. net.

In the first part of the book a brief account is given of the structure, metamorphosis, and classification of insects. The second part describes the more important beneficial and injurious insects of Britain, arranged according to their orders and families.

The appearance and life history of each is described, and recommendations made for their control.

The general principles of insect control and the composition and use of insecticides are dealt with, and the book concludes with short appendices on injurious Crustacea, Arachnida and Myriapoda, eelworms, and Mollusca. J.R.W.J.

Black Currant Gall Mite on Red Currants; The.

Massee. *Annual Report of the East Malling Research Station, 1926 and 1927.* East Malling, Kent, 1928.

The Black Currant Gall Mite (*Eriophyes ribis* Nal.) has in recent years become very common on red currants, causing failure of several plantations in Kent. Typical " big buds " are not produced, although in cases of severe attack the buds at the base of the bush in particular may tend to swell slightly. In some varieties a dense growth of buds results, which do not develop normally. In spring, infected buds may be easily recognized as they remain dormant. The mites leave the buds for the under surfaces of the leaves during the first and second week of April, and preliminary experiments indicate that spraying in the spring with lime sulphur, after the mites have begun to migrate, will prove a successful method of control. J.R.W.J.

Bulb Mite, *Rhizoglyphus echinopus* Fumoze and Robin; The Bionomics of the.

HODSON. *Bull. of Entomological Research*, XIX, pt. 2. October, 1928.

A short description is given of the various stages of the mite, and an account is given of its life history. The Narcissus flies, *Eumerus* spp. and occasionally *Merodon equestris*, act as distributing agents. Distribution also occurs when the bulbs are lifted and gathered in heaps, as the mites are free to wander from bulb to bulb. Numerous experiments were made to determine whether *R.echinopus* is a primary or secondary parasite of bulbs. It was found impossible to obtain injury to bulbs which were healthy when infected, but damaged bulbs, which otherwise would probably have recovered, were destroyed by the mites, which may also carry spores of injurious fungi from bulb to bulb. Bulbs should be lifted carefully, and damaged or rotting ones destroyed, and they should be periodically examined in store, and soft ones removed. Early treatment of bulbs infested with Nematodes is essential to prevent subsequent mite attack on damaged portions. Fumigation with paradichlorbenzene or the hot water treatment will destroy the mites.

J.R.W.J.

Greenhouse Whitefly; The. (*Trialeurodes vaporariorum* West).

SPEYER. *J. of the Royal Hort. Soc.* January, 1929.

The greenhouse whitefly was so numerous in the Wye Valley some years ago that an annual loss of £30,000 was caused in that district alone. These losses are unknown with modern methods of fumigation, which are discussed, but it is still impossible entirely to eradicate the pest. An account is given of the Chalcid parasite, *Encarsia formosa* Gahan, which is being bred and distributed in England. This parasite controls the pest on Tomato, Cucumber, Marrow, etc., but not on such plants as Tobacco, Bouvardia, Datura, Abutilon, and Eucalyptus, the foliage of which is repellent to the parasite. The spring is the best time for the introduction of the parasite into infected houses.

J.R.W.J.

Potato Virus Diseases; Studies on. V, Insect transmission of Potato Leaf Roll.

SMITH. *Annals of Applied Biology*, XVI, No. 2, May, 1929.

Attempts were made to transmit Potato Leaf Roll through the agency of the common potato feeding insects, but positive results were only obtained with *Myzus persicae*, both adults and nymphs transmitting the disease.

Two years' work on the transmission of the virus to the progeny of the infective Aphids gave negative results, and it is concluded that the virus is not inherited. It was shewn that the disease is not mechanically carried by adherence of the virus to the external mouth parts, since virus bearing aphids isolated for periods up to seven days on non-solanaceous plants immune to the disease, were still infective on the potato.

Seven varieties of potato were infected by means of *M.persicae*, and there was no apparent difference in degree of resistance.

J.R.W.J

Principles of Applied Zoology; The.

WARDLE. 8vo. XII, 427 pp., 56 figs. London: Longmans, Green and Co., 1929. Price 21s. net.

This book is an attempt to provide a summary of the whole field of applied zoology, that will be of value to the agricultural, medical, or zoological student. The first part deals with medical and veterinary zoology. The second deals with agricultural and horticultural zoology, and has chapters dealing with soil fauna; insect pests of cultivated crops, their life histories and the factors affecting their mortality and control, and the encouragement of beneficial birds.

The third part is devoted to animal industries including beekeeping, and the book concludes with a bibliography and an index.

J.R.W.J.

Problems of Applied Entomology; The.

WARDLE. 8vo. XII + 587 pp., 4 pls., 29 figs. Manchester: The University Press, 1929. Price 30s. net.

The first part of this book (pp. 1-247), is mainly a review of work on economic entomology that has been carried out since 1922, and is supplementary to "The Principles of Insect Control" by Wardle and Buckle, published in 1923. The second part of the book is a review of all the more important entomological problems of the world. A bibliography, author index, and subject index are included. J.R.W.J.

Red Spider Mite; The. (*Tetranychus telarius* L.).

SPEYER. *J. of Pomology and Hort. Sci.*, VII, No. 8, December, 1928.

A detailed account is given of the bionomics and control of the greenhouse red spider. Volatilisation of crude naphthalene by lamps at the rate of 10 oz. per 1000 cu. ft. space, for 10-12 hours is effective provided the temperature can be maintained at 70°F. This must be done before the middle of October, as the vapour will not kill mites which have left the plants. Details are given of methods of dealing with empty houses, and of the use of a petroleum oil emulsion spray on cucumbers, tomatoes, and melons. The spray is useless on carnations, as the bloom of the foliage absorbs the oil. The smallest possible quantity of soft soap, or caseinate should be used, and no spreader such as saponin should be added to the spray, since too large a proportion of emulsifiers or the presence of a spreader causes the oil to run off the mites and foliage. Mites may be trapped in dry straw strewn on the ground between plants or in strips of corrugated paper placed over the pipe hooks. The traps should be put down at the beginning of October, and removed and burnt at weekly intervals until the middle of November.

J.R.W.J.

Red Spider. The Fruit Tree. (*Oligonychus ulmi Koch*).
MASSEE. *Report of the East Malling Research Station, 1928.*

The increase of *O.ulmi* during recent years is considered to be due to the continued use of tar distillate washes which, while harmless to Red Spider eggs, destroys those insects such as *Anthocoris nemorum* and *Adalia bipunctata*, which prey on the Red Spider. An account is given of the life history of this pest, and of the plants it attacks. Tar distillates, lime washes, and other dormant sprays do not destroy the eggs. A pre-blossom lime sulphur spray (1-30) has proved the best method. It should be applied about a week before the blossom opens, preferably on a sunny day. In badly infected orchards, a second, post-blossom spray at a reduced strength (1-80 or 1-100) may be necessary. Results on plums are not so good as on apples, as they are very susceptible to spray injury, and treatment must be completed before the blossoms open. Liver of sulphur was also found to be an effective spray. J.R.W.J.

Tar-distillate Spraying and of Greasebanding against the Woolly Aphis of Apple (*Eriosoma lanigerum* Hausm); **Note on the use of.**

LE PELLEY. *Annual Report of the East Malling Research Station, 1926 and 1927.* East Malling, Kent, 1928.

Apple trees infested with Woolly Aphis were sprayed with a tar distillate wash, and on some of the trees, both sprayed and unsprayed, grease bands were also placed. The results showed that the value of grease banding is limited by the fact that the aphis can overwinter above ground, and that the destruction of all these overwintering forms by means of the spray is very difficult. It is also difficult, especially on old, rough barked trees, to prevent the aphides from crawling up between the band and the trunk. It is not considered that spraying with tar distillates with the sole purpose of destroying Woolly Aphis would ordinarily be an economic undertaking. J.R.W.J.

Turnip Mud Beetles; The. (*Helophorus rugosus* Ol. and *Helophorus porculus* Bedel).

PETHERBRIDGE. *Annals of Applied Biology,* XV, No. 4, 1928.

Serious damage has been caused during recent years by these pests in the East of England, especially to late sown white turnips. Swedes and rape are damaged to a lesser degree, and cabbage and kales only slightly injured. The adults feed on the leaves, but most of the damage is done by the larvae, which tunnel the bulbs and also feed on the developing leaves.

An account is given of the life history, and descriptions of larval, pupal, and adult stages are included. Early sowing is recommended, as no severe attack was noted on crops sown before July. The growing of cruciferous crops frequently on the same land is not desirable, and cultural operations during the latter end of May should destroy many pupae. J.R.W.J.

FORESTRY.

Abstractor:

W. S. JONES, M.A., M.Sc., Welsh Department, Ministry of Agriculture.

British Hardwoods; Their Structure and Identification.

L. CHALK, M.A., D.PHIL., and B. J. RENDLE, B.SC., A.R.C.S. (London: Under the Authority of His Majesty's Stationery Office, 1929). Price 5s. net.

The aim of this book, as stated in the Prefatory Note, is "to provide descriptions of the structure of the more important British hardwoods, illustrated with suitable photomicrographs, which should be of assistance to timber users who wish to confirm the identity of the timbers they are handling". This purpose is admirably fulfilled. As claimed, the text is written in simple, non-technical language. The descriptions are arranged in alphabetical order of common names and the type descriptions are followed by short references to related species and other woods which may resemble the native timber in name or general character. The photographs are on a useful scale of magnification and, except for the frontispiece, are intended to illustrate cross sections as seen under a pocket lens. A Key for the identification of the common British Hardwoods supplements the type descriptions. The value of the book rests on its simple, non-technical language, its clear presentation of facts, its Comparative Notes, its numerous and generally excellent illustrations and its cheapness rather than on any new information it presents. Fig. 30 is inverted and for uniformity the orientation should be corrected in future editions. The book closes with a useful bibliography of English works. The general get-up of the volume is unimpeachable. W.S.J.

Forest Trees; The Structure and Life of.

Dr. M. BÜGSEN. Third Edition revised and enlarged by Dr. E. Münch and translated by Thomas Thompson, M.Sc. (London: Chapman and Hall, Ltd., 1929). Price 30s. net.

This is a massive volume with text extending to 414 pages. Its size precludes the possibility of a detailed review of the contents as a whole. Its scope and character may, however, be in a measure indicated by an enumeraton of the titles of its various Chapters.

The subjects dealt with are:—

Chapter 1.—The Form of the Tree (52 pp.).
Chapter 2.—The Bud (27 pp.).
Chapter 3.—Properties and Life Processes of the Meristem (26 pp.).
Chapter 4.—The Elements of the Xylem (27 pp.).
Chapter 5.—The Tree Rind (24 pp.).
Chapter 6.—The Annual Ring (29 pp.).
Chapter 7.—Anatomical Basis of the technical Properties of Timbers (12 pp.).
Chapter 8.—The Leaves (71 pp.).
Chapter 9.—The Root (32 pp.).
Chapter 10.—Water Economy of the Tree (24 pp.).
Chapter 11.—The Mineral Nutrients (25 pp.).
Chapter 12.—Movements and Transformations of Substances in the Body of the Tree (17 pp.).
Chapter 13.—Flowers, Fruit and Seedlings (36 pp.).

Chapter 14.—Local Races (12 pp.).

The book is illustrated by 178 Figs., including some twenty-six Plates.

The translation of this well-known German book is a very valuable addition to English literature dealing with those subjects which are common ground for students of Botany and Forestry. It is, moreover, the most comprehensive book of its kind in the English tongue, and Mr. Thompson, besides showing great courage and initiative, has rendered a very great service by making the book available to English readers. He has given us a very readable and generally clear rendering, remarkably free from foreign idiom. The text has been prepared with obvious care and having regard to the size of the book it is amazingly free from verbal and other blemishes. As, however, is inevitable in a work of this character, a few minor errors have been overlooked and should be noted for correction in anticipation of a second edition, to which the book will surely run. Among them may be mentioned the following—*Euchalyptus* (p. 87), occurance (p. 77), periferal (p. 93), fibrcs (p. 120), lumena (p. 177), and esplainable (p. 360). Such botanimal terms as leguminosae, pomaceae, cupuliferae, etc., would look more familiar if printed with capital initials and in any case a uniform practice should have been adhered to throughout. In the Table on p. 124 the units in which the width of heartwood and sapwood are expressed do not appear to be stated.

It is obviously a very difficult matter to keep a comprehensive tome dealing with very varied aspects of a living organism quite up to date. The statement on p. 110 that " living constituents extend x x x only into the sap wood " and that on p. 125 that " in the heartwood all the living cells have died " is a perpetuation in substance of a statement found in other standard works (Cp. Strasburger's Text-book of Botany; Eng. Ed.) which is not in accord with the most recent information. Moreover, the figures (p. 124) indicating the depth to which living medullary ray cells have been traced into the stem of a tree should be compared with the observations of McDougal and Brown who have reported their discovery of living ray cells of over 250 years old.

One may legitimately question that except in a general sort of way the " thickness " (breadth) of the medullary " bands is best recognised in cross sections " and that " Sections of wood in the direction of the radius of the stem show the breadth (depth) of the x x x bands ". The one and only section in which these measurements can with certainty be accurately determined is the tangential section.

The statement (p. 111) as to the arrangement of rays in the true American mahogany should be more precise. One might not unfairly assume that it was intended to state that all the rays are arranged in tiers. If so, the statement is open to criticism.

The book as a whole may be viewed as a series of monographs rather than as a consecutive story of the life of a tree. Its separate chapters are invariably very informative and reflect an immensity of labour rarely met with and a capacity to assemble, summarise and suggest. Absorbing and instructive as are all the chapters, perhaps there is none which exhibits a greater freshness than the rather short final chapter on *Local Races*, contributed by Münch.

The bibliographical references given at the foot of the pages add very materially to the value of the book, and, while one may regret that they are mostly confined to German literature, one readily appreciates the soundness of the reason which Mr. Thompson gives for not extending these to other languages. The translator and the publishers are to be very cordially congratulated on the production of so fine a volume. The text is clear and the get-up excellent.

Mr. Thompson may be assured of the warm gratitude of his readers and the hope he expresses in the Preface that the volume may prove a useful addition to our forest-botanical literature has been fulfilled.

W.S.J.

LIVE STOCK.

Abstractors :

J. A. Fraser Roberts, M.A., B.Sc., F.R.S.E., British Research Association for the Woollen and Worsted Industries, Leeds; and A. D. Buchanan Smith, M.A., B.Sc., M.S.A., F.R.S.E., University of Edinburgh.

Albino Cattle Furnish Interesting Problem in Inheritance.

Wisconsin Sta. Bull., 405, pp. 65, 66, 1929.

Pink-eyed white cattle are reported as occurring in a grade Holstein-Friesian herd which tend to develop some pigment in the irises with advancing age, though the pupils remain pink. Available breeding reports indicate that the condition is not inherited in a simple manner.

J.A.F.R.

Bones of the Fowl; The Effect of Inbreeding on the.

L. C. Dunn. *Connecticut Storrs Sta. Bull.*, 152 (1928), pp. 58-112.

Successive generations of inbreeding resulted in a decrease in length of a number of bones. This decrease did not appear to be the result of delayed maturity. The decrease in all measurements was proportional. Family differences appeared in the mean bone lengths, though these decreased in successive generations. The ratio of certain bone measurements to each other became established in particular families and varied little in successive generations. The variability amongst inbred breeds was less than in outcrossed breeds.

In two crosses of inbred families the F_1's in one case had larger bones than either parent and in the other the F_1's were intermediate.

J.A.F.R.

Bulldog Calves in Cattle; How to select against. 1. A Possible Means of Selection for Non-Deformity Breeding in Dexter Cattle.

Walter Landauer. *Vet. J.* (1929), pp. 11-15.

2. Studies in Chondrodystrophy. IV. Differential Blood Counts of Chondrodystrophic Chicken Embryos and of Dexter Cattle.

W. Landauer and L. Thigpen, *Folia Haematologica* (1929), pp. 1-13.

Crew has shown that occurrence of bulldog calves in the Dexter breed of cattle is due to hereditary factors, and that it is possible by wise selection to avoid those strains which throw these deformities. If Landauer's results are correct, and there is every reason to believe in them, then the task of selection is easier, for an analysis of the blood will give indication of those animals which are likely to be parents of deformed calves. Certain cells called eosinophiles have their origin in the marrow of the long bones of the extremities, the part of the skeleton which is most affected in bulldog calves. Under normal conditions it has been well proven that these form about 5 per cent. of all the white blood cells. In those cattle which have thrown bulldog calves the writer found that the number of these cells had greatly increased, from 10.5 per cent. to 21.7. In the case of two bulls which had been specially selected for non-deformity breeding the average count was only 2.1 per cent.

It therefore appears that it is now practical virtually to prevent the occurrence of these monstrosities. As a start, till further information is available, it might be sufficient to test only the bulls used in the herd, and it might be taken as a wise course not to use a bull with an eosinophile count exceeding 7.5 per cent. It is not difficult for a competent veterinary surgeon to make the required analysis, and the Animal Breeding Research Department, University of Edinburgh, will be glad to assist any breeder who wishes to adopt this line of action. Breeders should communicate with Mr. Buchanan Smith.

In conclusion it may be stated that it is possible that the best show types have as a rule the largest number of eosinophiles and are therefore most likely to throw monstrosities. This, however, is not invariably the case, for the two bulls mentioned above with the low counts were respectively second and third in their classes at the Show of the Royal Agricultural Society of England. A.D.B.S.

Cattle Inheritance; A Résumé of.

J. W. Gowen. *Bibliographia Genetica*, Vol. 3, pp. 87-140, 1927.

A useful review of the genetics of cattle. J.A.F.R.

Duration of Gestation in the Goat; Variation in the.

S. A. Asdell. *J. Agr. Sci.*, Vol. 19, pp. 382-396, 1929.

The data on which these results are based are taken from the Kid Register of the British Goat Society, giving records for over fifty years to 1928. 6,342 gestations are recorded. The average length is 151 days with a variation from 107 to 200 days. Slight breed differences exist, and there is a variation according to time of conception, spring being shorter than autumn. The period is shorter in young than in older dams irrespective of the number of previous conceptions. The size of the litter has no effect on the duration of pregnancy. A.D.B.S.

Ein experimenteller Beitrag zum Voronoffschen Verfahren der männlicher Keimdrüsen.

C. Kronacher, P. Henkels, W. Schäper und J. Kliesch. *Zeit. Tierz. u. Züchtungsbiol.*, Vol. 16, pp. 209-231, 1929.

The authors of this paper have repeated the rejuvenation work of Voronoff, using goats. Normal controls, castrates, and males with transplanted testis were compared, body weight and various anatomical measurements being recorded. They were unable to discover any effect on body size or weight as the result of the Voronoff procedure. The histological findings were in harmony with the experimental results. J.A.F.R.

Genetic Studies in Sheep and Swine.

B. L. Warwick. *Ohio Sta. Bull.*, 481, pp. 122, 128, 1929.

The inheritance of black in sheep is found to depend upon a simple Mendelian recessive, and " chalk-face " upon a simple dominant factor. In inbreeding experiments with swine, the fourth generation of parent-offspring matings has been obtained and in this connection new characteristics are reported. J.A.F.R.

Hare and Rabbit; An Attempt to Cross.

J. Hammond and A. Walton. *J. Genet.*, Vol. 20, pp. 401-404, 1928.

The authors attempted to make these crosses using artificial insemination, but in spite of optimum conditions in certain cases, as far as these could be established, the attempt was not successful.

J.A.F.R.

Horn growth in cattle and goats; What determines. Investigations in genetics at the Wisconsin Station.

Wisconsin Sta. Bull., 396, pp. 64-67, 1927.

In physiological studies by W. F. Dove it has been found possible by the transplantation of tissues to produce on cattle or goats almost any type of horns, comparable to the solid horn of the deer, the sheathless horn of the giraffe, the casting and sheath renewal of the prong-horned antelope, and the rhinoceros type of horn, since the type of horn depends largely upon the character of the underlying bone structure to which it is attached. A.D.B.S.

Horns in Sheep; Growth of. The effect of castration on the development of horns in Rambouillet ram lambs.

J. E. Nordby. *J. Hered.*, Vol. 19, pp. 119-122, 1928.

In a study of the effect of castration on the growth of horns in Rambouillet rams at the Idaho Experiment Station, monthly measurements of the length, diameter, and spread of the horns in two normal rams and two rams castrated at three months of age, showed that castration reduced the growth of the horns about one-third in the succeeding four-week period and about one-tenth in the twelve-week period following castration. It was further found that the increase in the length and diameter of the horns occurs entirely at their base during growth.

A.D.B.S.

Inheritance in Dairy Cattle.

Illinois Station Report, 1928.

There are many points of interest to dairy breeders in this report.

W. W. Yapp found in the cross of Guernsey by Holstein that the inheritance of milk yield, percentage of fat content, percentage of protein, and percentage of ash in milk are controlled by the combined influence of a number of separately segregating units. The percentage of lactose in the milk was so nearly the same in the two parental breeds that its segregation could not be demonstrated.

Work was also done on colouring matter in the milk of the Guernsey and Holstein breeds which showed considerable breed differences. The cross breds of the first and second generation were intermediate between the parents in trend, with a slight inclination toward the amount of pigment in the milk of the lower pigmented parent. It appears that the colour, like other characteristics of the milk, is influenced by a number of factors, no one of which is dominant, though there is a suggestion that Holstein type of colour may be dominant.

Roberts and Yapp found no preponderance of one sex in the offspring of a sire. They stated the sex ratio of 8,196 dairy and beef cattle showed that there were among the Holsteins 94.6 males per 100 females, among the Ayrshires 96.0, Guernseys 80.6, Jerseys 106.1, and Herefords 101.8. The results showed no evidence that a given sire produced a great preponderance of one sex in his offspring.

Campbell shows that the size of fat globules in milk decreases as the lactation period progresses. There was no relation between the times when the fat globules of different cows showed their greatest decrease.

Gaines shows that persistency of lactation is a definite character, and he has developed a slide rule specially designed to save time in calculating persistency values. Preliminary comparisons show that persistency in fat percentage with advance in lactation is more a definite character of the individual cow. He also describes an instrument which measures the rate at which cows milk. A preparation claimed to stimulate milk secretion has been tried without any observed effect.

A.D.B.S.

Inheritance of Weight in Rabbits; Experiments on the.

M. S. Pease. *J. Genet.*, Vol. 20, pp. 261-309, 1928.

The author has succeeded in selecting from a Polish-Flemish F_2 population two strains of rabbits, one of which matures on the average at 172 days and the other at 300 days. These two families appear to breed true for this time difference. In this experiment the time of maturity was not appreciably affected by the season of the year at which the rabbits were born or at which they attained maturity. Maturity, too, was not affected by sex and in all probability not by litter size. A considerable degree of correlation was found between heavy weight and slow maturity, but in a number of cases this association did not exist.

The paper also includes interesting data on inbreeding. A tentative comparison is made with the results of Sewall Wright, though the author points out that the numbers he dealt with are not very great. The data refer to the Polish stock.

" (1) It would seem that absolute sterility has been bred out of the stock at the sixth or seventh generation.

(2) On the average the sterile animals are markedly heavier than the fertile animals.

(3) A consideration of the families in which the sterile animals arose points to the working of a single recessive sterility factor.

(4) There has been a rapid diminution in the fertility of the pure stock as measured by (*a*) the desertion quotient, (*b*) the viability, and (c) the proportion of sterile matings—in the last case the sterility seems to reach a maximum in the fourth generation, while in the first two cases the decline in fertility is more or less continuous.

(5) There is evidence to show that the cross-bred young in each generation have not suffered in constitutional vigour from the inbred condition of their parents.

(6) The litter size shows some decline, but it is only a very small and very gradual one.

(7) The weight of the animals raised to maturity shows no decline whatever ". J.A.F.R.

Lethal Muscle Contracture in the Sheep; The Inheritance of a.

J. A. Fraser Roberts. *J. of Genet.*, Vol. 21, pp. 57-69, 1929.

A preliminary paper on this subject was abstracted on page 400 of Vol. IV of this *Journal.* It is now shown that the defect depends upon a simple recessive factor. A general discussion is included on the subject of the existence of such a recessive lethal in stocks of farm animals. It is possible that sometimes there is a disturbance of the normal sex-ratio, but this point has to be left an open question. J.A.F.R.

Naked—A Recessive Mutation in the Rabbit.

D. A. Kislovsky. *J. Hered.*, Vol. 19, pp. 488, 489, 1928.

This case represents an addition to the list of cases of hairlessness of a genetic character in mammals. The rabbits possessed some hair covering but this was partial and defective. The teeth were also abnormal, leading to the death of the animals before they were a month old. The defect appears to depend upon a recessive factor. J.A.F.R.

Nedarvning av dobbeltlender—karakteren hos storfe. (The Inheritance of the Double-loined characteristic in cattle).

Chr. Wriedt. *Nordisk Jordbrugsforskning*, pp. 120-124, 1928.

The " hog-backed " character in cattle is not of very infrequent occurrence. There is excessive development of the muscles of the loins and thighs. The author, as the result of his investigations in Norway, comes to the conclusion that this condition depends upon a dominant factor, but that the factor is not always expressed when in the heterozygous state. J.A.F.R.

Period of Lactation and the Age of the Cow; The Joint Influence of the— on the Yield and Quality of the Milk.

T. J. Drakeley and M. K. White. *J. Agr. Sci.*, Vol. 18, pp. 500-506, 1928.

This paper compares the various results previously obtained by the authors. The total number of analyses on which the study is based is 6,566, taken from cows at the London Dairy Show from 1876 to 1925. Tables are given showing the influence of stage of lactation and age of the cow on the yield and quality of the milk for the Dairy Shorthorn, Jersey, Guernsey, Red Poll Ayrshire, Kerry, British Friesian and Lincoln Red Shorthorn breeds. These figures should form a useful piece of reference for those interested, but their practical application, at the moment, is not great. A.D.B.S.

Pulling Power; Weight found to be a Big Factor.

C. W. Crawford and E. T. Robbins, 1928-29, *Univ. Illinois Agr. Exp. Sta.*, p. 108.

Pulling power of 144 different teams was tested on the dynamometer of the Station. The records secured indicate that weight is one of the first essentials in a team used for pulling big loads. Horses making good records also were energetic but not flighty in disposition, were well trained, carefully hitched, and well shod.

The pulling contests in which 144 teams were entered also showed that in a group of horses of equal weight, those with the greater heart girth exerted the greater tractive force. Horses also must be in good flesh to do their best. A good disposition is a valuable asset, and a skilful driver is as necessary as good horses. Barefooted horses were unable to hold their own with well-shod teams.

The record for heavy teams made in 1927 when a 3,770 pound team of geldings, owned by E. B. Reeves, Morris, lifted 3,000 pounds and carried it 27½ feet, was unequalled in 1928. However, the record for teams under 3,000 pounds was broken when a farm team of grade Percherons belonging to August Pierson, Princeton, and weighing 2,880 pounds, raised a weight of 2,550 pounds and pulled it the full distance of 27½ feet. In its pull the Reeves team developed twenty-four horse power, showing the enormous reserve power of a good team. The tractive pull of 2,550 pounds is equivalent to starting a load of 38,100 pounds on granite blocks, fifteen or twenty consecutive times.

A.D.B.S.

Skull Defect in Swine; An inherited.

J. E. NORDBY. *J. Hered.*, Vol. 20, pp. 229-232, 1929.

To the growing list of hereditary defects in farm animals must be added this interesting example in pigs. The condition is due to an error in development which leads to a brain hernia. In most cases the defect is lethal but a few affected animals do survive. There is a suggestion that animals possessing the defect may tend to die very early during fœtal life, the result being abnormally small litters. The author does not consider that the evidence is sufficient as yet to prove conclusively the type of inheritance involved, but there is no doubt as to the fact of the defect being of a hereditary nature. J.A.F.R.

The Rex Rabbit.

W. E. CASTLE. *J. Hered.*, Vol. 20, pp. 193-199, 1929.

The Rex rabbit is an interesting example of what is apparently the mutation of a single gene resulting in a large structural alteration. In rabbits outer and inner coats are to be distinguished. The protective outer coat fibres are relatively coarse and the inner coat fibres are extremely fine. In the Rex rabbit the outer coat by a single step has been to all intents and purposes eliminated. This case is of great interest in relation to the probable mode of evolution of the fleece of the modern sheep, in which the outer coat has also almost disappeared. It is perhaps possible that the typical fleece of such a sheep as the Merino, composed almost exclusively of inner coat fibres, is the result of such a mutation in the past as that which has given the Rex rabbit in modern times.

The factor concerned is a simple recessive and Castle has studied crosses with all other known mutant characters in the rabbit (with one exception, *viz.*, " naked ", which is described in another abstract and which was not available) and found no evidence of linkage with any of them. The presumption is that the Rex factor is situated in a different chromosome pair from those which contain any other known mutants.

Castle also confirms the result of Pease, who discovered the character " yellow fat " and found it to be linked with the factor for albinism. Pease was in doubt whether the association was physiological or genetic though he favoured the latter hypothesis. Castle's results make it clear that it is a case of genetic linkage. J.A.F.R.

Uber einige Bastarde aus Kreuzungen von Original-Skudden (mischwollige ostpr. Landschafe) mit Merino-Fleischschafen und württembergischen Landschafen.

W. Kirsch. *Zeit. f. Tierzüchtung u. Züchtungsbiologie*, Vol. 15, pp. 345-358, 1929.

The wool fineness of the Merino was found to be dominant to the coarse mixed wool of the Skudde, with just a slight increase in variability in the cross. The crimpy character of the Merino fleece was more or less lost in the crossbred wool, which in spite of a high degree of fineness and loose lock-construction, had a greater staple length and gave a higher yield of clean wool.

In crosses between the Wurtemberg sheep and the Skudde definite segregation occurred as regards wool fineness. Some crossbreds had very fine uniform wool, others coarse mixed wool, and others were intermediate.

The short tail of the Skudde was dominant to the long tail of the Merino, but the short tail in the crossbreds was covered with wool instead of short, stiff hairs. J.A.F.R.

Variability of Yield of Milk and Fat of Individual Cows; Normal Day to Day.

Stephen Bartlett. *J. Agr.* Sci., Vol. 19, pp. 438-451, 1929.

Three cows were used for part of this work. The records of the weight of milk and butter fat content were made throughout a lactation period. In addition to this data, there were the monthly records of individual animals sampled at each milking on three consecutive days each month; the records covered five years and the greatest care was taken to prevent variation owing to change in the personnel of the milkers, particular care being taken that the cows should be treated quietly. It was found that the variability in the yield of milk and fat of cows was affected by many factors, especially the stage of lactation and the season of the year. Variability is high during the first month of lactation and usually highest in the month of May. It has a general tendency to be higher during the summer than the winter months. When cows are milked twice daily at unequal intervals the yield of milk obtained in twenty-four hours is slightly less variable if a morning milk yield is added to the subsequent evening yield, than if an evening yield is added to the subsequent morning yield.

If, however, the variation were due to varying quantities of milk retained in the udders of cows at milking time, then the author states as a suggestion incomplete milking as a possible cause of day to day variability, though he does not imply that this is necessarily the fault of the milker, being probably due to the cow being somewhat nervous as the result of discomfort, ill-health, or other causes.

The author argues that it would appear that variations in fat yield may be due to varying rates of secretion of fat as well as to incomplete milking. The fat yield was found to vary approximately twice as much as milk, and the reason for this may be found largely in the fact that the last milk drawn from the cow is considerably richer in fat than the total milk drawn at a complete milking, the result being that if a proportion of milk is retained in the udder at any milking the proportion of fat retained is correspondingly greater.

The author also suggests that there is a greater tendency for the rate of secretion of fat to vary more from day to day than the rate of secretion of milk. A.D.B.S.

Variasjonen i husdyrarter i genetisk belysning. (The Variation of Domestic Animals in the Light of Genetics).

CHR. WREIDT. *Nordisk Jordbrugsforskning*, pp. 129-142, 1928.

A critical examination from the genetic point of view of what might be termed the neo-Lamarckian view of the influence of domestication on variation in animals. J.A.F.R.

Variations and Yields of Milk and Butter Fat; Studies in Milk Secretion Based on the—produced at Morning and Evening Milkings.

S. BARTLETT. *J. Agr. Sci.*, Vol. 19, pp. 36-47, 1928.

The results of the test in the Guernsey and Dairy Shorthorn herds at the National Institute of Dairying at Reading which have been made since 1922 are analysed over a five-year period.

The weight of fat produced at each milking was calculated from the weight of milk and the percentage of fat, then by a similar classification to that used for milk yields, lactation curves were prepared for morning and evening yields of fat during each month of lactation. The yield of fat during a lactation period produces a curve which approximates to a straight line indicating that the rate of decrease in the production of fat is fairly constant throughout the lactation period. On comparing the curves for morning and evening yields it is observed that in early lactation the weights of fat yielded at the morning and evening milkings are practically the same, but as the lactation period progresses the difference between morning and evening yields becomes more and more pronounced, the yield of fat at the morning milking being always greater.

With regard to yield of fat in relation to age, a striking difference is found. First calvers in early lactation produce approximately the same or even a greater weight of fat at the evening milking than they do at the morning milking and this condition gradually disappears with the advance of lactation. The second calvers produce a little more fat at the morning milking, and in the case of the older cows the morning fat yield is proportionately greater; in all age groups, however, the proportional yield of fat at the morning milking is greater in the later stages of lactation.

The effect of apparent high udder pressure on the lactation curve is noted. The cows with high udder pressure yielded a lower weight of fat at the morning than at the evening milkings. It is suggested that not only does excessive pressure in the udder cause a decrease in secretion but that it also induces reabsorption of part of the milk.

Low proportional yields of milk fat at the morning milkings in early lactation have already been noted. The practical application of this observation would seem to be that if the cows are stimulated to secrete more milk, the stimulation should be accompanied by a shortening of the long milking interval in order to obtain the full benefit and to avoid a depression in the fat percentage of the milk.

The percentages of fat from month to month as shown in Table V are remarkably constant throughout the year, and although there is a depression during May this depression is not nearly as pronounced as is usually imagined, the actual fat percentage for May being about 0.15 per cent. below the mean for the complete year.

Since the food of the cow varies considerably during the year, the curve showing seasonal variation provides some information on the effect of foods on fat percentage; and the small differences at various seasons of the year support most of the experimental evidence which has been published showing that foods do not affect the percentage of fat in milk to any appreciable extent, unless those foods upset the health or digestion of the cows. A.D.B.S.

Visible Mutations following Radium Irradiation in Drosophila Melanogaster.

F. B. Hanson and E. Winkleman. *J. Hered.*, Vol. 20, pp. 277-286, 1929.

This paper reports no less than forty-nine germinal mutations arising from males treated with radium. The authors intend to study the linkage relations of these mutant genes. J.A.F.R.

Weight and Fat Production of Guernsey Cattle; The Relation between.

C. W. Turner. *J. Dairy Sci.*, Vol. 12, pp. 60-73, 1929.

This study was based on records of more than 2,700 cows.

The relationship between weight and fat production is given by the equation :- -

yearly fat production = 0.77 weight—301.73.

The increase in both these quantities follows the same exponential course.

When age was constant, there was an increase of only 20 lbs. of fat for each 100 lbs. of body weight increase. The figures show that only about 25 per cent. of the increase in fat production with age is due to increase in body weight, the remainder being due to the development of the udder. The partial correlation of weight with fat and age confirmed this estimate. J.A.F.R.

Wool Covering on Face, Ears, and Legs.

E. G. Ritzman. *New Hampshire Sta. Tech. Bul.*, 37 (1928), p. 35.

The results of a study of the inheritance of wool covering on the face, ears, and legs of sheep, made by crossing Southdowns, Hampshires, Oxfords, and Dorsets with Rambouillets, indicated no simple dominance for heavy or light covering of wool on these parts. There was marked variability in the F_1 offspring in the different crosses, which indicated heterozygosity in the parent breeds. There was a general tendency for the F_2's to show a greater variability, but with less wool covering than on the F_1's. There was a still further decrease in the wool of the head in the F_3's, which was explained as due to the failure in the selection of F_2 sires with a heavy covering of the face, ears, and legs.

It is concluded that the wool covering of the face, ears, and legs was subject to several groups of complex factors independent of each other. A correlation between the diameter of the fibre and the degree of wool covering on the face indicated that the diameter of the fibre of animals having fleece over the face was usually less than 27 to 30 μ.

J.A.F.R.

X-Rays and Somatic Mutations.

J. T. PATTERSON. *J. Hered.*, Vol. 20, pp. 261-267, 1929.

An extremely fruitful field of work at the present time is the investigation of the effects of X-rays on mutation. It has been found possible by this means to induce in a stock far more frequent mutation than would occur in an untreated stock. It is of great interest to note that the mutations produced do not appear to differ in their nature from those occurring naturally and also that the majority of mutations are lethal.

This paper deals particularly with mutations in somatic tissues. It was found that somatic mutations are produced by the use of X-rays and than these are similar in nature to those occurring normally, but the incidence of mutation is greatly increased. The main biological effect of irradiation appears to be the production of breaks in the chromosomes. The work as far as it has proceeded indicates that pieces only and not entire chromosomes, are eliminated. J.A.F.R.

Yield and Quality of Milk; Factors affecting the. 1. The Age of the Cow.

R. R. KAY, A. C. McCANDLISH. *J. Agr. Sci.*, Vol. 19, pp. 342-371, 1929.

Using 738 pedigree Ayrshire cows with authentic milk records from the counties of Dumfries, Kirkcudbright and Wigtown, the authors have produced an interesting and instructive paper showing the effect of age on the yield and quality of milk. These 738 cows gave 4,380 recorded lactations. The average Ayrshire appears to produce the greatest quantity of milk and butter fat at seven years of age. The total yield of a heifer is about 85 per cent. of a seven year old cow. As regards total butter fat it is somewhat higher. This accounts for butter fat percentage being highest in heifers, and the authors come to the conclusion that a heifer with a low butter fat percentage is unlikely ever to increase that percentage in a subsequent lactation. The writers are of opinion that the increase in production at maturity is more closely associated with high initial production than with persistency of production.

A number of practical points are discussed. A.D.B.S.

PLANT PATHOLOGY.

Abstractor:

T. WHITEHEAD, M.Sc., PH.D., University College, Bangor.

Apple Scab and its Control in Northern Ireland.

A. E. MUSKETT and E. TURNER. *J. Min. Agr. (Northern Ireland)* Vol. 11, pp. 26-42, 1929.

The authors describe experiments carried out on Bramley's Seedling trees, which variety is stated to be very susceptible to attack in Northern Ireland. They conclude from four years' observations that the production of winter spores in withered leaves is the most important factor in the over-wintering of the disease in this variety. Winter spraying with a tar oil wash was of no value in controlling scab, but a very satisfactory control was achieved by spraying three times in summer with excess Lime-Bordeaux mixture (2¼, 8, 40).

Lime-Sulphur, even when the possibility of fruit-drop has been eliminated as far as possible by using Bordeaux for the petal-fall and post petal-fall applications, has not given satisfactory results.

Burgundy (2, 2½, 40) was efficient and did not cause appreciable leaf-scorch in these experiments, but since it has been reported to cause scorch in other districts, its use is not recommended at present. A better control was obtained on the fruit by the addition of sugar (4 lb. per 40 gall.) or glue (½ lb. per 40 gall.), but there was no indication that the addition of a proprietary casein spreader increased the value of the mixture, nor did the addition of lead arsenate.

The authors emphasize the importance of early spraying, *i.e.*, in the " pre-pinking " and " pinking " stages of flower development; other sprayings must be given at petal-fall and again subsequently. In some seasons it is desirable to spray again some six weeks after petal-fall. In this case Lime-Sulphur (1-60) should be used since Bordeaux leaves a thin powdery film on the fruit.

One spraying only is practically useless and if the best results are to be obtained the full spraying programme must be carried out.

Spraying not only increases the actual crop yield but also the size of individual fruit. Since the effects of spraying are cumulative, it must be included in the routine work for each year.

Over a period of four years the extra money value of the crop produced by one hundred sprayed trees as against that of the same number of unsprayed trees was £200, or £2 per tree—the whole of the summer spraying expenses amounted to £14. The cost of spraying each season has been calculated as 6½ per cent. of the crop value of sprayed trees.

T.W.

Apple Scab; The Control of.

W. Goodwin, E. S. Salmon and W. M. Ware. *J. S. E. Agric. College, Wye, Kent,* No. 26, pp. 34-46, 1929.

(1) Allington Pippin and Newton Wonder.

Similar plots of trees of these two varieties were sprayed three times with two types of Bordeaux Mixture, made respectively with hydrated lime and quick lime. The fungicidal powers of the two mixtures proved, as in 1927 in similar experiments, to be identical and eminently satisfactory. In the control plots, the percentage by weight of scab infected apples was eighty-two in Allingtons and eighty-three in the Newtons. In the sprayed plots, the percentage in Allingtons was twelve and in the Newtons fourteen and seventeen. No appreciable leaf-scorch was caused on either variety by the spraying. Russetting of the fruit occurred to a slight extent, but was appreciable in only 8.1 to 3.7 per cent of the Allingtons and 0.14 to 0.28 per cent of the Newtons.

(2) Worcester Pearmain.

In 1927 and 1928, plots of this variety were sprayed two and three times respectively with home-made Bordeaux or Bordeaux Paste (Bordorite). In 1927 the percentage of scab-free apples in the Bordeaux Mixture plots was sixty-one and fifty-five; in the Bordeaux Paste plots twenty-nine and twenty-four; and in the control (unsprayed) plots thirty-nine and twenty-two. In 1928, the percentages in the respective plots were three (both Bordeaux plots); 0 (both plots), and 0 (both plots).

Three applications, including the early spraying at the " pink-bud " stage, did not, in either year, secure a better control than two applications. No early infections of opening leaves occurred in 1927 whereas in 1928 this was general before the date of the first spraying. The failure to control the disease in 1928 is attributed to early and continued infections by winter sports arising from the dead leaves of the previous season. T.W.

Oat Smuts; The Biology of. II, Varietal Resistance.

K. SAMPSON. *Ann. Appl. Biol.*, Vol. XVI, No. 1, pp. 65-85, 1929.

Various methods for testing varieties of oats for resistance to smut are described. A technique which involves the germination of shelled grain in sand of low moisture content, at a temperature of 22°C gave the most satisfactory results. Data are given of the infection capacities of four biological species of *Ustilago avenae* and three of *U. levis*. Two of these are described for the first time.

Pure line selections of *Avena strigosa* vary in their resistance to U. levis (C_1 strain) from 0 to 100 per cent.

A large number of commercial samples of oats was examined for smut infection. The attack was heaviest in varieties belonging to the Winter, Potato, or Sprig groups. Samples yielding over 10 per cent. smut were examined microscopically and typical resting mycelium of *Ustilago avenae* was found abundantly on the pales.

Plant Growth; Manganese as an Essential Element for.

G. SAMUEL and C. S. PIPER. *Ann. Appl. Biol.*, Vol. XVI, pp. 493-524, No. 4, 1929.

Manganese becomes necessary to plants at an early seedling stage, and remains necessary until a late stage in growth. The symptoms of manganese deficiency are essentially an arrest of development followed by death of the undeveloped tissues at the growing points, and the use of the word " chlorosis " as the primary symptom is mis'eading. In many cases a special type of chlorosis of the upper parts of the plant does occur before death of the tissues.

Rye developed to maturity in water-cultures on an amount of manganese which did not allow the complete development of oats. A concentration of manganese of one part in fifty million parts of nutrient solution allowed complete development of rye, and would probably be sufficient for oats also if a method of continuous change of solution could be arranged. Evidence is given that the minimum quantity of manganese which will allow healthy growth of Algerian oats is about fourteen parts per million of the dry matter at the flowering stage. On certain soils oats are unable to absorb this minimum quantity, and they then suffer from the " Grey Speck " disease, a true manganese deficiency disease which can be cured by application of a soluble manganese salt. On soils with abundant available manganese, considerably more manganese is absorbed by oats than is required for normal development. The amount absorbed varies greatly, and in all probability depends to some extent on soil reaction and soil aeration.

Such factors as the presence of organic matter, or excess of calcium ions, which have been claimed as causes of the Grey Speck disease of oats have been shown to play no part in the appearance of this trouble in water-cultures where a soluble manganese salt is present. These factors cannot themselves render manganese unavailable when it is present in a soluble form. This does not exclude the possibility that they may later be found to have some effect, in conjunction with other factors as yet undetermined, in rendering manganese unavailable in certain soils. None of ten different rarer elements tried, nor the combination zinc, copper, boron and aluminium, was able to replace manganese in the growth of oats. T.W.

Potato Blight; The Control of—in Northern Ireland. I. Spraying versus Dusting.

A. E. Muskett. *J. Min. Agric.* (*N. Ireland*), Vol. II, pp. 54-62, 1929.

A series of experiments carried out in Northern Ireland from 1924 to 1927 have shown that the use of dusting powders, as obtainable at the present day, for the control of ordinary potato blight, is neither so efficient nor so economical as ordinary spraying.

The use of these powders (four of which were used) gives some control over blight, but they cannot be recommended in preference to a recognised mixture for spraying.

Potato Secondary Leaf-Roll; A Preliminary Note on the Development of—in the Year of Infection.

T. Whitehead and J. F. Currie. *Scot. J. Agr.*, Vol. XII, No. 2, pp. 214-215, 1929.

The authors describe experiments in which plants of two varieties in ten different stages of growth, were infested for the same length of time by the same number of aphides carrying the leaf-roll virus. In the variety Arran Comrade, all plants, from the youngest up to those planted eight weeks before infestation, developed secondary symptoms of leaf-roll; whilst in Kerr's Pink this only occurred in plants from the youngest up to those planted five weeks' before infestation.

It is suggested that where late planting is followed by an early aphis infestation, there may be an apparently inexplicable increase in the amount of leaf-roll found in the crop. Early and constant rogueing out of infected plants is advised in those seed-growing areas of Scotland where transmission of virus diseases is not rapid. The experiments show the need for information as to the time of aphis infestation before the amount of leaf-roll in a crop can be taken as an index of its prevalence in the seed-stock. T.W.

Potato; Sprain or Internal Rust Spot of.

S. Burr. *Ann. Appl. Biol.*, Vol. XV, No. 4, pp. 568-585, 1928.

Necrosis of the tuber was found to be due to two distinct diseases. (1) Sprain or Internal Rust Spot and (2) a disease hitherto unrecorded and now named Corky Bacteriosis of the Xylem. The former is much the more important and accounts for 98 per cent. of the tissue destruction.

In Sprain the tissue attacked is the parenchyma both within and without the vascular ring. The lesions vary greatly in form and may consist of spots, arcs, streaks or irregular blotches—the larger ones being generally hollow in the centre. The soil on which Sprain occurs in a virulent form is a light sandy loam, deficient in organic matter and one on which potatoes scab severely. The disease is apparently slight when the crop is lifted but develops rapidly and continuously during storage. Infection of the crop arises mainly from contaminated soil and not from affected seed. The causative organism is new to literature and is here named *Bacterium rubefaciens.* It is suggested that the organisms enter at a very early stage through the stomata or lenticels of the tuber-bearing stolon, remaining quiescent in the water-filled intercellular spaces of the tuber and becoming active only when the latter ripens.

Corky Bacteriosis produces a browning and lignification of the vascular ring macroscopically resembling the Ring Bacteriosis caused by *B. solanacearum.* It is caused by an organism new to literature and here named *Bacterium suberfaciens.* The disease is transmitted from the mother tuber to its progeny by way of the stolons. It may also be contracted from infected soil, apparently by infection of the stolon or the stolon-end of the tuber. T.W.

Potato Trouble; The Control of a Serious.

F. E. Edwards. *J. Min. Agr.*, Vol. XXXVI, No. 3, pp. 284-242, 1929.

The author describes experiments designed to control " Potato Sickness "—a malady which causes serious losses in some English (and Welsh—Abs.) counties. The " sickness " is associated with the presence of the fungus *Corticium (Rhizoctonia) solani* and the eelworn *Heterodera schachtii.* Artificial inoculation of soil with either or both of these organisms caused a check to growth of potatoes, but this was temporary except when both fungus and eelworm were used together. It is surmised, however, that some unknown factor also may be operating under field conditions. Whether this is so or not, a considerable degree of control was obtained by the use of " drained Creosote Salts " which, it is advised, should be broadcast twelve days before planting—at the rate of 8 cwt. per acre and then immediately ploughed in to a depth of six inches. T.W.

Sugar Beet; Treatment of—to prevent Seedling Diseases.

R. C. Woodward and W. A. R. Dillon-Weston. *Ann. Appl. Biol.*, Vol. XVI, No. 4, pp. 542-566, 1929.

It is shown that treatments used to disinfect the " seed " may be harmful, they may exert no influence, or they may be of considerable value. The trials have shown the beneficent effects of an organic compound containing mercury. This material increased the " plant " in the majority of cases, and this increase varied between 12 per cent., under some conditions, and in increasing amounts up to 198 per cent. under more favourable conditions. An increase in the vigour of young plants was noted occasionally. Quantitative tests showed an increase in both the green and dry weight per seedling as the result of treatment. The beneficial action of treatment is not due to the influence of water.

The organic compound containing mercury was the most effective in reducing diseased growths during laboratory tests; a proprietary dust was nearly as efficient. Steeping in a half per cent. solution of carbolic acid for half an hour was ineffective. Treatment of the clusters with 60 per cent sulphuric acid did not appreciably improve " plant " establishment, but this treatment followed by the mercury treatment increased the number of plants considerably.

Field trials conducted for one season on a field scale have not shown an increase in the percentage of sugar as a result of the treatment of " seed ", but a slight increase in yield and in the total number of roots per acre was noted as the result of treatment with the organic compound containing mercury. The proprietary dust was not noted as being responsible for reducing the " plant " in the field but its beneficent action was not as uniformly apparent as that of the mercury compound.

Carbolic acid at a strength of half per cent. was definitely injurious when used for steeping purposes. Furthermore, trials show no benefit from a modified form of this treatment in which a 8½ per cent. solution is sprinkled on the " seed ". Other materials tested were found to be of doubtful value. Certain samples of commercial " seed " as supplied treated with a mercury material were found to be infected to a considerable extent by *Phoma Betae.* Such " seed ", it was found, could be efficiently disinfected by careful re-treatment, with marked beneficial results. T.W.

Swedes; Dry-Rot of—Some Field Observations and Experiments on Control.

J. C. NEILL. *N.Z. J. Agr.*, Vol. XXXIX, No. 2, pp. 86-93, 1929.

The treatment of swede seed by soaking for one hour at 50°F. to 60°F., followed by dipping for five-ten minutes up to 135°F., both in a 0.25 per cent. solution of Semesan did not prevent the appearance of dry-rot in the field. With the five minute dip, field germination was seriously affected only above 135°F.

It is not practicable to free a swede crop from dry-rot by eliminating diseased plants. In an early sown crop which has been well grown, and properly thinned and cultivated, dry-rot infection may spread over the entire crop before the winter from a very few original sources of infection. Late sowing, lack of thinning, and poor cultivation, with consequent poor crop of small crowded bulbs appears to reduce greatly the incidence of rot. T.W.

Swedes and Turnips; The Dry-Rot of—caused by Phoma lingam (Tode) Desm.

P. A. MURPHY and W. HUGHES. *J. Dept. Agr. for the Irish Free State*, Vol. XXIX, No. 1.

Phoma lingam occurs on the seed of swede turnips of British origin —the maximum percentage of infected seeds found being 0.2. The dry-rot fungus is capable of persisting throughout the winter on the remains of diseased roots in the soil, and has been proved to convey infection from this source to the new crop in the following year.

Data derived from field experiments in 1927 show that when twelve varieties, each of which came from the same source, were sown at two widely distant stations, approximately corresponding amounts of dry-rot developed in nine of them, while in three much more disease developed in one place than in the other. This is interpreted to mean that the amount of disease which developed in the first nine varieties probably reflects the amount of infection they carried with them (*i.e.*, seed infection); while observations are recorded indicating that infection from other sources, such as manure or soil, played a part in at least two of the remaining varieties at one station. Similar field experiments were controlled in 1928 by a mycological examination of the seed. Seed of six of the varieties used in 1927, from the same source in each case (the sources being also the same as in 1927) were sown in three widely separated places. A trace of *P. lingam* (one infected seed in 4.650) was found on one variety only, and this variety developed the greatest amount of disease in each of the three experiments. The difficulty of referring the great excess of disease which developed in one variety in 1928 to the minimal amount of seed infection found is discussed, but there are difficulties at least as great in referring it to greater susceptibility, although this may have been a contributory factor. On the whole, it must on the evidence be concluded that seed infection was mainly responsible. T.W.

Tulips; "Breaking" in.

D. M. Cayley. *Ann. Appl. Biol.*, Vol. XV, No. 4, pp. 529-539, 1928.

"Breaking" in tulips is infectious and can be induced by bringing the internal tissue of a normal bulb in contact with tissue from a "broken" bulb during the resting stage. The degree of "breaking" appears to be proportional to the amount of infected tissue introduced. The phenomenon of "parrotting" has appeared in the "broken" flowers from bulbs infected with a small amount of "broken" tissue.

Injections of filtrate from "broken" tissue have given negative results so far. T.W.

Wheat Bunt; Control of

W. A. Dillon-Weston. *Ann. Appl. Biol.*, Vol. XVI, No. 1, pp. 86-92, 1929.

Results of control experiments over a period of four years are given. The wet treatment, with formaldehyde and copper sulphate, are compared with the dry treatment, using copper carbonate. The seed was more heavily inoculated with bunt spores than usually occurs in practice and under these conditions untreated grain gave an average of 73.7 per cent. bunted ears; formalin treated grain (1 : 240) averaged 0.27 per cent.; copper sulphate (2½ per cent.) gave an average of 4.5 per cent.; and copper carbonate (3 oz. dust per bushel) averaged, for two years, 12.5 per cent. Copper sulphate appreciably reduced the percentage germination, whereas this only occurred once with formalin and not at all with copper carbonate.

The dusting method is discussed. It is shown that infection varies directly with the spore load on the grain and that the efficiency of the dusting treatment is proportional to the rate of contamination. For the usually slightly contaminated seed samples this treatment has been effective in controlling bunt. The cost of such dusting treatment is estimated at eightpence per acre sown, as against fourpence for copper sulphate and threepence for formalin.

An experiment on feeding "dressed" wheat to poultry is described, and although no adverse effect followed a daily ration of 4 oz. dressed grain over a period of five days, the author considers it inadvisable to feed such treated grain to poultry. T.W.

Wheat; Observations during 1927-28 on the Incidence of "Rusts" on various selected Varieties, with special reference to the Intensity of Yellow Rust.

W. A. R. Dillon-Weston. *Ann. Appl. Biol.*, Vol. XVI, No. 4, pp. 533-541, 1929.

Observations on the incidence of yellow, brown and black rust on selected wheat varieties are recorded, and the "intensity" of yellow rust is also given.

It is shown that bunt increases the susceptibility of varieties to yellow rust. It is suggested that in testing wheat varieties for resistance to yellow rust (*P. glumarum*) the seed should be previously bunted, and that if no yellow rust then appears that the variety should be regarded as truly resistant.

The author further suggests that a generalisation cannot be made that the twenty-eight chromosome group is more resistant to pathogens than the forty-two chromosome group, and also that there is no firm foundation for believing that the species and varieties of wheat which are resistant to rust are resistant to bunt, and *vice versa*. T.W.

SOILS AND MANURES.

Abstractor:

RICE WILLIAMS, M.Sc., University College, Bangor.

Decomposition and Action of Nitrogen and Carbon Compounds in Manure; Investigations on the.

K. SCHEIBE. *Landw. Vers. Sta.*, 1929, 108, No. 1-2, pp. 61-114.

It is concluded that manure stored in receptacles suffers less loss, decomposes more readily in the soil, and is better utilised by crops than that kept in the ordinary way in open heaps or deep stalls.

R.W.

Farm Yard Manure; The Germ Content of Variously Handled.

W. GOETERS. *Landw. Vers. Sta.*, 1929, 108, No. 1-2, pp. 1-60.

It is shown that the temperature of fermentation has a profound influence on the number, type, and activity of the organisms in the manure. Both high and low temperature reduced the number of organisms. The urea bacteria were found to be among the more resistant organisms and to play an important part in the ripening of the manure. Hot fermented manure when mixed with soil showed a higher nitrifying capacity, more readily assimilable nitrogen, and increased crop yields more than that fermented at a lower temperature. R.W.

Fertilisation of Soil Poor in Lime; Comparative Tests of Different Carbonates.

G. RIVIÈRE and G. PICHARD. *Compt. Rend. Acad. Sci.*, Paris, 1928, 187, 28, pp. 1068-1070.

Equivalent amounts of calcium, magnesium, sodium and potassium carbonates were added to alkaline soils poor in lime but well supplied with nitrogen, phosphorus, and potash. Oats and wheat were grown on the soils so treated. The greatest increase in yield was obtained with sodium carbonate. This is attributed to its action both in increasing the nitrification of the reserve nitrogen of the soil and in supplying the need of the plant for sodium. R.W.

Hydrogen-ion Concentration for the Cycle of Nitrogen Transformation in the Soil; On Significance of.

C. OLSEN. *Compt. Rend. Lab. Carlsburg*, 1928, 17, p. 8.

By adjusting a strongly acid humus soil to different degrees of hydrogen-ion concentration with quicklime the author found that ammonification can proceed in soils whose pH value lies between 3.7 and 9.0. The process is most active on the alkaline side—pH values 7.0 to 8.5. Nitrification takes place in soil having pH between 3.7 and 8.8 When the soil is rich in ammonia the activity of the process increases with increasing pH value reaching its optimum at a pH of 8.8. Under natural conditions in soil having pH between 4.0 and 8.0 nitrification will be limited by ammonification, the rate of the latter process determining the rapidity of the former. The results indicate that there may be in soils either different races of nitrifying organisms, each with its special pH optimum, or that the organisms are capable of adjusting themselves to wide variations of pH value. R.W.

Long-continued Studies of Soil Treatment with Special Chemicals.

New York State Sta. Rpt., 1928, pp. 21-23.

As the result of thirty years experiments it is concluded that the sulphur in calcium sulphate, magnesium sulphate, and iron sulphate did not cause any improvements in crops and did not cause any marked differences in their composition. Cumulative additions of calcium sulphate reduced the yields of most crops; Lucerne being one of the few exceptions. Magnesium sulphate had little effect on yields, but brought about the undesirable effect of increasing the magnesium content of the crop at the expense of the calcium. It is also stated that there is no indication of any harmful effect on the growth of most crops from the application of either sodium sulphate or sodium chloride, although continued for thirty years. R.W.

Lysimeter Investigations.

New York State Sta. Rpt., 1928, pp. 18, 19.

The work reported is a continuation of previous work. Barley was grown on two different soils following two years of lucerne and two years of timothy on each soil. On the less productive soil the barley yields were nearly three times greater following lucerne than following timothy, and on the more productive soil the ratio was nearly 2 : 1 in favour of the part which had been growing lucerne. The nitrogen content of the drainage waters was much higher in the lucerne rotation than in the timothy rotation in the year in which the residues were incorporated into the soil. The difference was not so great in the year during which the green manure crop was grown. More calcium, magnesium, chlorine, and sulphates, however, were leached out from the timothy than from the lucerne rotation. R.W.

Nitrate Production and the Retention of Moisture in Soils; The Effect of Cultivation on.

R. P. BARTHOLOMEW and W. H. METZGER. *Arkansas Sta. Bul.*, 1928. 231, pp. 32, 33.

On uncultivated plots, weeds were found to have taken up a large proportion both of the nitrogen present as nitrate and of the soil moisture supply. Rye and vetch proved very effective cover crops for preventing the loss of nitrogen as soluble compounds during the winter months. R.W.

Nitrates; Distribution of—in Three Layers of Fallow Soil.

J. B. Smith. *Soil Science*, 1928, 26, No. 5, pp. 347-350.

A one-fiftieth acre plot was ploughed in spring, again ploughed in midsummer and rolled, and cultivated throughout the experiment sufficiently to prevent weed growth. It was treated with fertiliser which was thoroughly mixed with the top seven inches of soil, and the nitrate content at various intervals determined in the layers 0-7, 7-14 and 14-24 inches from the surface. For the entire season there was little loss of easily nitrifiable nitrogen from the 2 ft. depth of soil. Weather conditions and activities of micro-organisms caused temporary disappearances of nitrates. Nitrates moving downwards after leaching rains were often retained in sub-soil layers and at such times the quantities there present were in excess of those remaining in the surface layer. Under midsummer conditions nitrates leached from the upper soil layers were returned by the upward movement of soil water. R.W.

Nitrogenous Fertilisers; The Influence of—on the availability of Phosphate and Potassium.

J. F. Fudge. *Alabama Sta. Bull.*, 1928, 227, p. 49.

Acid forming fertilisers such as ammonium sulphate, ammonium nitrate, Leuna salpetre, and urea caused an increase in water soluble potassium, but this increase was at the expense of the potentially available supply as indicated by certain tests. These fertilisers also caused a marked decrease in the availability of phosphate. The physiologically basic nitrogenous fertilisers, sodium nitrate, calcium nitrate and calcium cyanamide, caused an increase in phosphate availability and decreased the water soluble potassium, but tended to conserve the potentially available potash. R.W.

Report on Drainage Tanks.

D. S. Jennings. *Utah Sta. Bull.*, 1929, 209, p. 80.

As the result of experiments on the improvement of the drainage of heavy clay soils by calcium chloride treatment it was found that an application of one and a third tons per acre was sufficient for the reclamation of the first foot, and two and two-thirds for the second foot. R.W.

Sodium Silicate; A Preliminary Note on the Effect of—in Increasing the Yield of Barley.

R. A. Fisher. *J. Agr. Sci.*, 1929, 19, No. 1, 132-139.

A statistical analysis of data from experiments at Rothamsted, in which the addition of sodium silicate has been found to increase the yield of barley to a considerable extent, appears to show that the silicate acts by making available to the plant the actual reserves of soil phosphate. R.W.

Soil Investigations at Hood River.

Oregon Sta. Biennial Rpt., 1925-26, p. 76.

From data obtained for orchard soils it is apparent that a leguminous crop, such as vetch or lucerne, disked or in some manner turned under, is the means of inducing the formation of large amounts of nitrogen in nitrate and ammonia form, thus supplying to the trees and crops the much needed nitrogen for thrifty appearance and growth. R.W.

Soil Nitrate; Desirable—levels for certain Market Garden Crops.
J. B. Smith. *Soil Sci.*, 1928, 26, No. 4, pp. 265-279.

Results of experiments carried out at the Rhode Island Experiment Station on the correlation of nitrate concentration determined to a depth of seven inches of soil with the growth of certain market garden crops. It is suggested that it is desirable to maintain the following nitrate levels throughout the growing season: (1) Celery, lettuce, and late beets, ten parts per million; (2) Cabbage, fifteen parts per million; and (3) Early tomatoes and late spinach, twenty parts per million. R.W.

Soil Nitrate Studies.
Colorado Sta. Rpt., 1928.

The relation between nitrate behaviour and the nature and quantity of organic matter applied has been studied. It was found that ploughing under materials rich in nitrogen increases the nitrates after a time, whilst ploughing under materials low in nitrogen such as straw temporarily reduces nitrates. The theory put forward to account for this is that in the decay of the low nitrogen material there is an insufficient supply of nitrogen for the metabolism of the decay organisms. These organisms therefore take their necessary supply of nitrogen from the soil, thus reducing the soil nitrates. This action is temporary and apparently does not hold over into succeeding years. R.W.

Soil Reaction and Nitrogen Fixation.
P. G. Krishna. *J. Amer. Soc. Agron.*, 1928, 20, No. 5, pp. 515-518.

A very good correlation was found between soil reaction and nitrogen fixation. A progressive increase in nitrogen fixation with decreasing soil acidity being observed. No correlation could be demonstrated as between bacterial numbers and nitrogen fixation, bacterial numbers and soil reaction, or soil reaction and disappearance of dextrose. R.W.

Soils and Fertilisers.
Sir E. J. Russell. *Agr. Research in 1928*, Royal Agricultural Society of England.

The following points connected with fertilisers are dealt with: (1) Production and consumption; (2) Field experiments; (3) Effect of time of application of fertilisers; (4) Effect of potassic fertilisers on fruit trees; (5) Experiments on grass land; (6) Production in Denmark. Under the soils heading are the following: (1) Soil analysis and soil surveys; (2) Soil improvement, (*a*) Soil acidity and liming, (*b*) Cultivation, (*c*) The use of green manure and farm yard manure; (3) Soil micro-organisms. R.W.

Sources of Material used as Fertilisers and Soil Amendments.
M. Nelson. *Arkansas Sta. Bull.*, 1928, 231, p. 24.

Ground limestone and chalk used alone showed no superiority over other forms of lime, but when used in conjunction with a complete fertiliser they appeared more effective than other forms. Applied alone, bone meal gave better yields of oats than basic slag, but in combination with manure both gave similar higher yields. R.W.

Special Investigations.
Oregon Sta. Biennial Rpt., 1927-28, p. 75.

The permeability of heavy textured soils was improved in the case of alkali soils by treatment with sulphur and in the case of acid soils by means of lime and manure. Certain peat soils are reported to have been improved by manure, potash fertilisers, lime, and especially by potassium nitrate. R.W.

Synthetic Fertiliser Salts when Mixed with Limestones and Dolomite; The Chemical and Physical behaviour of certain.

W. H. McIntire and K. B. Sanders. *J. Amer. Soc. Agron.*, 1928, 20, No. 7, pp. 764-770.

Air-dry limestone or dolomite when mixed with each of five concentrated ammonia compounds were shown to have lost very little or no ammonia after standing at room temperature for thirty-six days. By adjusting the moisture content to 6 per cent. the loss was measurable in some cases but this loss was only one-seventh of the analytical error permitted to the fertiliser analyst. The physical condition of the mixtures suffered when exposed to a circulating moist atmosphere, in three cases the salts became practically liquid. This tendency was eliminated by mixing in the proportion of one part ammonia to four parts limestone. Two parts of Nitrophoska and one part ground limestone remained granular and free from caking for some weeks in a, greenhouse. R.W.

VETERINARY SCIENCE.

Abstractor:

Norman Bissett, M.R.C.V.S,. University College, Cardiff.

Vaccination against Tuberculosis with Bacillus Calmette-Guerin.

A. C. Rankin. *Canadian Journal of Research*, Vol. 1, No. 1, May, 1929, pp. 48-85.

The author records experiments carried out with the B.C.G. vaccine on some 250 calves during a period of four years.

The vaccination was found to be entirely harmless, and to cause no interference whatever with normal development of the vaccinated animals. In most cases such animals reacted subsequently to the Tuberculin Test. Those which were immediately exposed to infection after vaccination showed an increase in resistance to tuberculosis as compared with unvaccinated controls.

Calves vaccinated with B.C.G. and subsequently kept under sanitary conditions for a period in order to permit resistance to develop before exposure to infection, showed 80 per cent. immunity against 14 per cent. for the controls.

The tuberculous lesions found in vaccinated calves were, in general, much less pronounced, as well as less numerous than those in unvaccinated animals.

Vaccinated animals which were not exposed to natural or experimental infection showed no lesions, either macroscopic or microscopic on post-mortem, even one year after vaccination.

The author concludes that vaccination with B.C.G. produces resistance in bovines to tuberculosis infection, and that the B.C.G. is non-virulent for bovines. N.B.

AGRICULTURAL BOOKS, 1929.

The following list, prepared by the staff of the National Library of Wales, is a selection of the more important books on the science and practice of Agriculture published during the year 1929, together with a few omitted from the list for 1928. The list supplements *The Hand List of Books on Agriculture* issued by the National Library, *third edition*, 1926, copies of which can be obtained on application to the Librarian, The National Library of Wales, Aberystwyth.

App, F. Farm economics . . . *2nd ed. rev.* Philadelphia: Lippincott, 1929, pp. 700. ill., diags. *Lippincott's Farm Manuals.* ... ... 12s. 6d.

Arthur, J. C. The plant rusts (Uredinales). New York: Wiley, 1929. pp. vi, 446. ill., diags., bibl. ... 32s. 6d.

Ash, E. C. Farming. London: Methuen, 1928. pp. xiv, 168. front., pls. ... ... 12s. 6d.

Auchter, E. C., *and* Knapp, H. B. Orchard and small fruit culture. New York: Wiley, 1929. pp. xviii, 584. ill., bibl. ... ... 25s. 0d.

Bear, F. E. Theory and practice in the use of fertilisers. New York: Wiley, 1929. pp. viii, 348. ill., maps, bibl. *Wiley Agricultural Series.* ... ... 20s. 0d.

Blundell, F. N. The agricultural problem. London: Sheed and Ward, 1928. pp. 90. bibl. ... 1s. 0d.

Boyle, J. E. Agricultural economics. *3rd ed. rev.* Philadelphia: Lippincott, 1928. pp. x, 520. ill., bibl. *Lipincott's College Texts. Agricultural Ser.* ... ... 12s. 6d.

Carlos, A. S. Feeding stuffs. London: Chapman & Hall, 1928. pp. xii, 152. pls. ... ... 5s. 0d.

Carrier, E. H. The thirsty earth: a study in irrigation. London: Christophers, 1928. pp. 222. front., pls., maps, bibl. ... ... 10s. 6d.

Cleghorn, W. S. H. Farm building and building construction in South Africa . . . *3rd ed.* London: Longmans, 1928. pp. xxiv, 352. ill., diags., and fdg. plans. ... ... 25s. 0d.

Co-Operative Union, Ltd., The. Farm and store: new hope for the land. The agricultural policy of the Co-operative Union, by G. Walworth. Manchester: The Union, 1929. pp. 12. ... ... 8d.

Cornwall County Council, The. Agricultural experiments in Cornwall, by W. Hawk. Truro : Netherton and Worth, 1929. pp. [vi], 252. diags. ... 2s. 6d.

Cox, J. F., and **Megee**, C. R. Alfalfa. New York : Wiley, 1928. pp. xii, 102 front., ill., diags. ... 7s. 6d.

Davids, R. A. Fruit-growing in South Africa. Bungay pr., Clay and Sons. 1928. pp. 532. ill. ... 27s. 6d.

Davidson, H. C. Fruit culture. London : Lane, 1929. pp. x, 142. ill. ... ... 3s. 6d.

Davis, K. C. *Ed.* Horticultural enterprises. Philadelphia : Lippincott, 1929. pp. x, 466. ill. *Farm Enterprise Series.* ... ... 10s. 6d.

De Kruif, P. H. Hunger fighters. [Sketches of American agricultural scientists.] London : Jonathen Cape, 1929. pp. 348 ... ... 12s. 6d.

Digges, J. R. G. The practical bee guide : a manual of modern bee-keeping . . . *6th ed.* London : Simpkin, Marshall, 1928. pp. vi, 306. front. (port.), ill., diags. ... ... 3s. 0d.

Earle, F. S. Sugar cane and its culture. New York : Wiley, 1928. pp. viii, 356. ill., bibl. *Wiley Agricultural Series.* $4.50

Edmonds, C. R. *and* **Walker**, G. K. Diseases of animals in tropical countries. *2nd ed.* [of "Diseases of animals in South Africa" by C. R. Edmonds]. London : Baillière, Tindall & Cox, 1929. pp. xii, 408. ill. ... ...

Filley, H. C. Co-operation in agriculture. New York : Wiley, 1929. pp. xx, 468. ill., diags., bibl. *Wiley Agricultural Series.* ... ... 20s. 0d.

Getman, A. K. Future farmers in action. New York : Wiley, 1929. pp. xiv, 116. *The Wiley Farm Series.* ... ... 7s. 6d.

Goldstein, B. F. Marketing : a farmer's problem. New York : The Macmillan Co., 1928. pp. xiv [ii], 330. bibl. $3.50

Gothein, M. L. A history of garden art, ed. by W. P. Wright, trans. from the German by Mrs. Archer-Hind. London : Dent, 1928. 2 vols. front., ill., bibl. ... ... 84s. 0d.

Guy & **Co.**, *Publishers.* Guy's creamery ready reckoner. Cork : Guy and Co., 1928. pp. [vi], 226. ... 21s. 0d.

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